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Lyman J. Briggs
Director

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HYDRAULIC LABORATORY BULLETIN
SERIES A

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

BULLETIN VIII
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WASHINGTON

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DIRECTORY.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

Compiled by the National Bureau of Standards,
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Edited by Herbert N. Eaton,
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INTRODUCTION

The following issues of National Bureau of Standards Hydraulic Laboratory Bulletins, Series A and Series B, are still available:

Series A. Current Hydraulic Laboratory Research in the United States.

Bulletin	IV-1,	January 1936
"	IV-2,	July 1936.
"	V-1,	January, 1937.
"	VI ,	" 1938.
"	VII	" 1939.

Series B. Hydraulic Laboratories in the United States.
First Revision, 1935.

A law recently enacted by the Congress prohibits sending Government publications through the mail free of postage unless a request therefor has been received. Consequently, the National Bureau of Standards is revising its mailing lists to which various publications are sent. If you wish to receive future issues of this Bulletin, it will be necessary for you to write to the Director, National Bureau of Standards, requesting that your name be placed on the mailing list for this series, provided you have not already done so.

Key to Projects.

(a) Title of project:
(b) Project conducted for:
(c) Nature of project:
(d) Investigators:
(e) Correspondent:
(f) Purpose:
(g) Method and scope:
(h) Progress:
(i) Remarks:

CURRENT PROJECTS IN HYDRAULIC LABORATORIES

COLUMBIA UNIVERSITY. (Dept. Civil Engineering).

(987) (a) HYDRAULICS OF BROADCRESTED WEIRS.
(c) Research (partly a series of Graduate Theses)
(d) T. H. Robinson, H. Franke, R. Guernsey and A. E. Matzke under direction of Prof. Bakhmeteff.
(f) A study of flow over broadcrested weirs with particular emphasis on the physical aspects of the phenomena. Successive flow patterns and basic interrelations presented dimensionlessly in terms of dynamic similarity. Investigation of the possible use of the outflow section as a meter.
(g) Observations, including detailed measurements of velocity and pressure distribution, are carried out in a special precision weir, built into the regular tilting flume of the laboratory.
(h) Project three-quarters completed.

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(988) (a) HYDRAULICS OF SLUICES.
(c) Research.
(d) F. Ebetsch and A. E. Matzke under direction of Prof. Bakhmeteff. Patterns of flow through rectangular sluices with particular emphasis on the physical aspects of the motion. Dimensionless representation of the main interrelations. In submerged motion, study of the spreading of turbulence in the boundary zone between the jet and the roller. The phenomenon of the "submerged jump".
(g) The studies are carried out in the tilting flume of the Laboratory.
(h) Research practically completed.

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(989) (a) FRICTION PATTERNS IN HYDRAULIC STRUCTURES.
(c) Research (partly Graduate Thesis).
(d) R. Guernsey and A. E. Matzke under direction of Prof. Bakhmeteff.
(f) A broad basic study of friction patterns as they occur in practical structures is contemplated. It is assumed that friction in most instances does not comply with the established type and is distinctly of the boundary layer form.
(g) Research in preliminary stage. Suitable apparatus and methods are being investigated. In the first series a study is contemplated of boundary layers as they occur in the flow through sluices, over broad-crested weirs, and down steep chutes. A specially constructed Pitot tube will be used and the obtained results interpreted in the light of available theory.

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(990) (a) FLOW OF AIR THROUGH GRANULAR MEDIA.
(c) Research (Graduate Thesis)
(d) D. Lomb assisted by N. V. Feodoroff under direction of Prof. Bakhmeteff.
(e) Professor H. L. Parr and Mr. Dutcher.
(f) Study of the resistance to the flow of air through uniform media composed of lead shot of different sizes. The investigation follows previous research, the particular purpose being to compare the coefficients obtained for air with those previously observed for different liquids.
(g) The standard apparatus, previously used, is attached to an air blower and air volume meter, made available through the courtesy of the Mechanical Engineering Laboratory.
(h) Research completed.

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(991) (a) EQUIVALENT DIAMETERS IN THEIR RELATION TO THE MECHANICAL COMPOSITION OF GRANULAR MEDIA MIXTURES.
(c) Research (Graduate Thesis).
(d) John Walsh assisted by N. V. Feodoroff under direction of Prof. Bakhmeteff.
(e) Professor D. Murmister.
(f) The project is in continuation of preliminary results previously obtained and reported to the Intern. Congr. of Appl. Mechanics, 1938. Mixtures consisting of lead shot of different sizes, as well as natural sands, will be investigated. By artificially proportioning the constituent fractions, a wide range of mixture types will be analyzed. The experiments will be carried out in the previous testing apparatus with water and air as fluids.
(h) Research in preliminary stage.

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(992) (a) GRANULAR MEDIA FLOW PATTERNS.
(c) Research.
(d) N. V. Feodoroff under direction of Prof. Bakhmeteff.
(f) A detailed systematic study of flow forms in wells, coffer dams, and other practical cases is contemplated. Detailed observations of the velocity and pressure fields are to be interpreted in the light of theory.
(g) A special apparatus is in process of construction. Glass balls of comparatively large diameter will be used for the solid framework with highly viscous oil for the fluid. The combination permits to obtain flow at low Reynolds Numbers, corresponding to the Darcy Zone, without the interference of capillary action,
(h) Research in preliminary stage.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(290) (a) VELOCITY DISTRIBUTION IN STREAM CHANNELS.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(291) (a) BACK-WATER BY THE MANNING FORMULA.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(292) (a) DISPERSION CURVES OF MANNING'S COEFFICIENT OF ROUGHNESS.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(293) (a) FLOOD WAVES SUBJECT TO FRICTION CONTROL.
(c) Scientific research.
(e) Robert E. Horton.
(h) Results of the experiments at the Horton Hydrologic Laboratory on the movement of flood waves in an experimental channel 5-5/8 in. wide and 120 ft long, together with a comparison of these results with those given by different theoretical formulas, are contained in a paper entitled "Channel Waves Subject Chiefly to Momentum Control," Robert E. Horton, Contribution from Division of Research, Soil Conservation Service and Horton Hydrologic Laboratory, Voorheesville, N. Y., (mimeographed). The same paper with some omissions has been published in the Bulletin of the Permanent International Association of Navigation Congresses. Copies may be obtained from the Horton Hydrologic Laboratory (50¢). See also: "Rain Wave Trains", Robert E. Horton, Trans. American Geophysical Union, 1938, pp. 368-374; "Seddon's and Forchheimer's formulas for crest velocity of flood waves subject to channel friction control," Robert E. Horton, Trans. American Geophysical Union, 1938, pp. 374-382.

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(385) (a) SURFACE RUNOFF PHENOMENA.
(c) Scientific research.
(e) Robert E. Horton.
(h) A complete analysis of the phenomena of surface runoff in accordance with the Horton infiltration theory has been made and will be published shortly by the Horton Hydrologic Laboratory. This analysis, based on the Manning slope formula and the law of continuity, is strictly rational as applied to rectangular runoff plats and has been verified by experimental examples. It is shown that the rate of runoff from such a plat can be accurately represented by the equation

$q_s = K_s \delta^M$, where δ is the depth of overland flow along

the outlet margin of the plat and K_s and M are dependent on the slope, length of overland flow, coefficient of roughness and type of overland flow. The experimental data show that the type of sheet or overland flow from plats and small areas ranges from laminar flow (M = 3.0) to fully turbulent flow (M = 5/3) but that in the majority of cases what may be described as "mixed flow" prevails, the flow over certain portions of the plat being turbulent and over other portions laminar. An index of turbulence has been developed, given by the equation $I = 3/4(3.0 - M)$. In many cases the exponent M is about 3.0, corresponding to 75% turbulent flow. Several new types of flow have been found in connection with runoff plat experiments, including subdivided flow where there is a dense grass cover on the plat, and the exponent M is close to unity. Where active erosion occurs, the actual runoff may take place by traveling back-water behind mud flows or debris dams, in which case the flow rate may remain sensibly constant with wide variations in the depth δ. Studies have been made which permit the infiltration theory of runoff as developed analytically for plats to be extended to larger drainage basins.

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(386) (a) WIND VELOCITY NEAR THE GROUND.
(c) Scientific research.
(e) Robert E. Horton.
(b) (d), (f) and (g). Earlier issues of this bulletin contain these details.
(h) Im this research an attempt is being made to evaluate the difference between the wind velocity curves above the ground surface for conditions of laminar and turbulent flow, respectively.

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(738) (a) SURFACE RUNOFF PHENOMENA - CHANNEL PHASE.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(g) An application of the Manning formula and the equation of continuity or storage equation to the determination of the transformation of a stream rise in its course through stream channels. The method is based on channel storage, and the research includes:
(1) Development of methods of determining the volume of channel storage from hydrographs, including determination of stream widths and channel storage volumes for rising and receding stages during the passage of a stream rise;
(2) Application of the stream stage-storage relations to determination of channel-inflow graph from channel-outflow graph;
(3) Effect of various factors, such as volume of channel storage and location of area from which surface runoff is derived on form of channel-outflow graph;
(4) Synthesis of channel-outflow graphs from channel-inflow graph or surface-runoff graph.
(h) This research has reached the point where the results are being worked up for publication. Two papers growing out of this research have been completed and are pending publication, one "A preliminary study of the determination of stream width from the hydrograph", by Robert E. Horton, the other, "Flood volumes", by Robert E. Horton and Richard Van Vliet. The latter paper is being published by the Interstate Commission on the Delaware River Basin and copies will be available shortly from that commission or from the Horton Hydrologic Laboratory.

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(841) (a) EVAPORATION FROM WATER SURFACE - AN ANALYTICAL AND EXPERIMENTAL STUDY.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(f) To evaluate the effect of wind movement on evaporation from lakes and water surfaces, with particular reference to the separate conditions existing, according as the wind movement is laminar or turbulent; also to supply an analytical basis for determination of area factor or relation of evaporation from lakes and reservoirs to that from evaporation pans.
(g) The method includes an analytical study of the transport of vapor across a water surface by wind action, whether laminar or turbulent, and the removal of vapor from the water surface by diffusion, convection and turbulence, checking the results by comparison with observed data under various conditions.

(h) The investigation has reached a point where the results are ready to be put in final form for publication, but work on this project has been temporarily suspended to permit the completion of certain other researches.

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(842) (a) RAINFALL PHENOMENA.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(f) To provide working data and rules for the application of rainfall records to the estimation of surface runoff.
(g) The research is based on detailed analysis of hourly rainfall records at regular U. S. Weather Bureau stations and certain other stations having recording rain gages. The research includes studies to determine the relative rainfall intensity and duration in different parts of a drainage basin during the same storm, and the relation of rainfall intensity and duration to storm conditions, particularly cold and warm fronts. It also includes a detailed study of the quantity of rainfall excess from rain falling at intensities exceeding different infiltration-capacities of the soil, the patterns of rain intensity graphs at different stations, and the quantity of rainfall excess on areas where most of the rain gages are of the non-recording type. An attempt is being made to work out various index quantities characterizing the rainfall regime of a given location in terms of average rain intensity.
(h) Some features of this research are nearing completion and results will be published from time to time as they become available.

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(993) (a) INFILTRATION-CAPACITY.
(c) Scientific research.
(e) Robert E. Horton.
(h) This research is closely related to that on surface runoff phenomena. Its purpose is to determine the factors and variables governing the rate of infiltration of water into the soil during rain. The more important independent variables have been found to be initial soil surface condition, initial soil-moisture, and type of vegetational cover, if any. Only a moderate degree of correlation seems to exist between soil type itself and infiltration-capacity throughout the middle portion of the range of soil texture. Infiltration-capacity is defined as the maximum rate at which the soil surface, when in a given condition, can absorb rain as it falls. It is found that the infiltration-capacity is related to time or duration of application of water through the equation

$$f = f_c + (f_0 - f_c)\, e^{-K_f t},$$

where f is the infiltration-capacity at the time t from the beginning of rain, f_0 is the initial infiltration-capacity and f_c a constant, called the surface minimum infiltration-capacity. In this equation values of f are expressed in inches per hour and time in hours. Since f_c is apparently sensibly constant for a given soil, and there is a close relation between f_0 and the initial moisture content of the soil, this equation can be used to predict the march of infiltration during a given storm and consequently furnishes a base for determining in advance the runoff coefficient which will apply to a given drainage basin in a given storm. Some of the results of this research have been given in the following papers: "Interpretation of Runoff Plat Experiments in relation to Soil Erosion," presented before the Soil Science Society of America, Washington, D. C., December 1938, published in the Transactions of that society for 1938; "Analysis of Runoff Plat Experiments with Varying Infiltration-capacity", Robert E. Horton, Trans. American Geophysical Union, 1939, pp. 693-711. Copies may be obtained from the Horton Hydrological Laboratory, Voorheesville, N. Y. (25¢). Additional results of this research will appear in a forthcoming paper entitled "Methods of Analysis of Sprinkled Runoff Plat Experiments", which is being prepared in cooperation with the U.S. Soil Conservation Service, Research Division.

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CLEMSON COLLEGE

(994) (a) HYDROLOGIC STUDIES - TWELVE MILE RIVER WATERSHED.
(b) and (c) Hydraulic Laboratory teaching and Engineering Experiment Station cooperative project.
(e) Professor D. D. Curtis.
(h) Gagings made in connection with class instruction, and as special observations. Rainfall records made by U.S.G.S., U.S.W.B., S.C.S., and certain college agencies are available. Roughness coefficient values have been obtained by slope, area, discharge method.

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THE JOHNS HOPKINS UNIVERSITY.

(995) (a) DETERMINATION OF THE DISCHARGE COEFFICIENTS FOR STANDARD CIRCULAR ORIFICES DISCHARGING WATER.
(b) Master's thesis.
(c) Laboratory project.
(d) George Dugan Johnson.
(e) Professor F. W. Medaugh.
(f) The development of a technique for making standard, circular orifice plates which are sufficiently identical to give consistent discharge coefficients, and the determination of what those discharge coefficients should be for water.

(g) Pressure measurements were taken by means of hook gages and piezometers. Discharges were measured by weight and volumetrically. The following sizes of orifice were used: quarter inch, half inch, three quarter inch, one inch, and two inch.
(h) The experimental work has been completed and the thesis will be finished by February 1, 1940.
(i) The results indicate that the coefficients obtained by Hamilton Smith and by Strickland are more nearly correct than those obtained by any other investigators.

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LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE.

(28) (a) HYDROLOGICAL STUDY OF CITY PARK LAKE DRAINAGE AREA.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) Study of rainfall, runoff, and evaporation.
(g) The rainfall is measured in six standard cans and a Ferguson Weighing Recording Rain Gage, placed at various points over the 507 acre drainage area. The control is a concrete weir. An attempt will be made at arriving at the evaporation from the lake by knowing the amount of water that is being turned into the lake during dry periods and the amount that is being discharged.
(h) Records have been taken since April 1, 1933, and will be reported as a University Bulletin about June, 1940.

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(224) (a) FACTORS AFFECTING THE EVAPORATION FROM A LAND PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) To determine the effect of the various meteorological factors on evaporation.
(g) This station consists of a standard U. S. Weather Bureau land pan, and a standard U. S. Weather Bureau rain can. Other meteorological data are obtained from a nearby station maintained by the Geology Department of the University.
(h) Records have been taken since June 1, 1933, and will be reported as a University Bulletin about June, 1940.

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(225) (a) COMPARISON OF EVAPORATION BETWEEN A LAND PAN AND A FLOATING PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and Assistants.
(e) Dr. Glen N. Cox.
(f) Evident from title.
(g) A U. S. Geological Survey type floating pan is used, about which a barricade has been placed to reduce wave action. A recording thermometer and an anemometer have been installed so that a continuous record of lake temperatures and of wind movement may be obtained. A standard rain can is used.
(h) Records have been taken since October, 1933, and will be reported as a University Bulletin about June, 1940.
(i) The original galvanized pan was replaced by a copper one and the change was accompanied by a considerable increase in evaporation.

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(863) (a) STUDY OF FLOW THROUGH A PIPE ORIFICE.
(c) General scientific research for Master's thesis.
(d) F. B. Sessums.
(e) Dr. Glen N. Cox.
(h) See Bulletin VII, January, 1939.

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LEHIGH UNIVERSITY.

(996) (a) MODEL STUDY OF SPILLWAY, SPILLWAY CHANNEL AND STILLING BASIN FOR CLARK CREEK DAM.
(b) Eastman, Gannet, Fleming, Consulting Engineers, Harrisburg.
(c) Design project.
(d) and (e) Dr. Arthur T. Ippen.
(f) (1)-To design a high-velocity channel below the spillway of a given complex curvature in such a way as to remove the high, standing cross-waves.
(2)-To design a gradually enlarged channel-section and the following stilling basin so as to obtain uniform dissipation of energy in the hydraulic jump and uniform velocity distribution at the downstream end.
(g) A model 1:40 was constructed in the laboratory about 40 ft long. The standing waves were removed by banking of the channel bottom. Banking was also resorted to successfully to spread the stream in the enlarging channel portion and to achieve the objectives stated under (f).
(h) Work completed in May.
(i) No formal report.

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(997) (a) MODEL STUDY OF SPILLWAY, SPILLWAY CHANNEL, AND STILLING BASIN FOR WILD CREEK DAM.
(b) Municipal Water Authority of the City of Bethlehem, Pennsylvania.
(c) Design project.
(d) Dr. Arthur T. Ippen and Charles A. Lee.
(e) Dr. Arthur T. Ippen.
(f)(1)-To design a channel-contraction below the spillway of 2 to 1 without high standing waves.
(2)-To design an enlargement of the high velocity channel of 1 to 2.5 in the portion preceding the stilling basin in order to reduce the height of the jump and to insure uniform energy dissipation.
(g) A model 1:36 was constructed of the entire layout. Both objectives (1) and (2) were successfully attained by use of banking of the channel-bottom.
(h) Reprints of illustrated article in Lehigh Alumni Bulletin available for distribution.

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(998) (a) CONTRACTIONS AND ENLARGEMENTS OF OPEN CHANNELS AT SUPER-CRITICAL VELOCITIES.
(b) Master's thesis.
(c) Laboratory project.
(d) Charles A. Lee.
(e) Dr. Arthur T. Ippen.
(f) To develop general methods of design preventing high standing waves for even relatively large specific energy gradients.
(g) A special high velocity flume 12 by 10 in. and 35 ft long is under construction in addition to the suitable experimental setup of the previous project.
(h) Problem analyzed. Experiments in progress.
(i) Work to be completed in May 1940.

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UNIVERSITY OF MICHIGAN. Naval Tank.

(999) (a) INCREASE IN RESISTANCE ON SHIP MODELS DUE TO SHOAL WATER.

(1000) (a) SCALE EFFECT ON A SERIES OF GEOMETRICALLY SIMILAR SHIP MODELS DUE TO SHOAL WATER.

(1001) (a) COMPARISON OF "STAR" CLASS HULL FORMS.

(1002) (a) ROLLING OF SHIP MODELS.

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UNIVERSITY OF MICHIGAN, Civil Engineering.

(1003) (a) ANALYSIS OF THE FLOOD HYDROGRAPH.
(b) General research.
(c) General research.
(d) E. F. Brater.
(e) E. F. Brater.
(f) To determine more dependable methods of breaking the flood hydrograph down into its various components.

(g) A study of the shape of the flood hydrographs of a particular stream in relation to the amount and duration of rainfall which produced them.
(h) The project is in the preliminary stage.

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(1004) (a) CENTRIFUGAL REACTION PUMP.
(b) Graduate School research.
(c) General investigation.
(d) A. F. Sherzer with some assistance at times.
(e) A. F. Sherzer.
(f) To determine the probable commercial value of this new type of pump as well as to determine its laws and characteristics of operation.
(g) Tests will be made on a full size pump of about 1 1/2 to 2 cfs capacity.
(h) Equipment nearly complete.

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(1005) (a) EVALUATION OF FACTORS AFFECTING VARIATIONS IN RUNOFF COEFFICIENT.
(b) General research.
(c) Departmental.
(d) Charles F. Bird.
(e) Professor C. O. Wisler.
(f) To evaluate the factors that affect the run-off coefficient with special reference to magnitude and intensity of rainfall, antecedent rainfall, storm distribution, and seasonal influence.
(g) To the present time these studies have been confined to the Muskingum River basin in Ohio. Thirty-two storms have been studied and numerical expressions have been developed for each of these factors for use in determining the desired correlation.
(h) Studies in progress.

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(1006) (a) ACCURACY OF AREAL RAINFALL DETERMINATION.
(b) General research.
(c) Departmental.
(d) R. B. Ebbets.
(e) Professor C. O. Wisler.
(f) To find the relation between drainage basin density of rain gages and accuracy of mean rainfall determination.
(g) Taking one or more drainage basins having fairly flat terrain and densely distributed rain gages, first find the mean rainfall on the basin for each of a number of storms of different patterns using all the station records. Then eliminate the records obtained at a certain number of the stations distributed uniformly over the basin and determine the mean rainfall based on the remaining records. Then eliminate an additional number of stations, repeating the determination each time until only a few stations remain. Finally curves of relation between percentage of error and area represented per gage will be derived for each different storm pattern.
(h) Studies being initiated.

UNIVERSITY OF NEW HAMPSHIRE.

(1007) (a) THE FLOW OF WATER OVER HORIZONTAL SHARP EDGE CIRCULAR WEIRS.
(b) Project conducted for Master's degree in Civil Engineering.
(c) Experimental and mathematical.
(d) Salvatore Grasso.
(e) Salvatore Grasso.
(f) To check the existing empirical constants for horizontal circular weir discharge formulas, to correct any errors which may be found to exist, and to propose a new formula if such seems desirable.
(g) 2", 4", and 6" diameter weirs were tested over a wide range of head.
(h) Laboratory tests have been completed, and mathematical studies and report are in progress.

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NEW YORK UNIVERSITY.

(881) (a) FREE OUTFALL FROM CIRCULAR CONDUITS.
(b) New York University.
(c) Master's thesis.
(d) J. C. Morgan.
(e) Prof. J. K. Vennard.
(f) To obtain the characteristics of jet trajectory, drop-down curves, etc., for use in the design of leaping weirs, and with a view toward using the outfall as a metering device.
(g) Laboratory measurements using 4" to 12" transite pipes, with flows up to 2.0 cfs.
(h) Tests on 4" pipe completed and data being correlated.

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(1008) (a) A STUDY OF SHARP-EDGED ORIFICES.
(b) New York University.
(c) Undergraduate Thesis.
(d) W. Schmidt.
(e) Prof. J. K. Vennard.
(f) To obtain complete and non-dimensional data on orifice coefficients.
(g) Experimental measurements of coefficients for orifices from 0.045" to 3" diam. operating under heads from zero to 5 ft.
(h) First tests on smallest orifice completed.

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(1009) (a) A STUDY OF THE MANNING "n" IN VARRIED FLOW.
(b) New York University.
(c) Master's Thesis.
(d) T. J. Driscoll.
(e) Prof. J. K. Vennard.
(f) To observe the variation of "n" with velocity and hydraulic radius in varied flow.

(g) Laboratory measurements in 4" to 12" transite pipes flowing partially full.
(h) Tests on 4" pipe completed and data being correlated.

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(1010) (a) A STUDY OF SIDE-CHANNEL WEIRS.
(b) New York University.
(c) Master's Thesis.
(e) Prof. J. K. Vennard.
(f) To obtain a general equation for side-channel weirs.
(g) Experimental measurements on a sharp-crested weir installed in a rectangular channel. Weirs of length up to 6 ft, a width of channel up to 2 ft, height of weir up to 20 inches, rates of flow up to 3 cfs.
(h) Preliminary studies being made and equipment being designed.

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OREGON STATE COLLEGE.

(681) (a) FLOW AROUND BENDS IN OPEN CHANNELS.
(b) Committee on Hydraulic Research, Am. Soc. Civil Engineering, J. C. Stevens, Chairman, Portland, Oregon.
(c) A research project on flow around bends in open channels.
(d) C. A. Mockmore.
(e) Prof. C. A. Mockmore.
(h) Laboratory work completed; preparation of report under way; progress report available.

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(1011) (a) FLOW THROUGH ORIFICES.
(b) Department of Civil Engineering.
(c) Laboratory experiment on discharge coefficients.
(d) C. A. Mockmore and Fred Merryfield.
(e) Prof. C. A. Mockmore.
(f) To study the effect of angle of approach on orifice coefficients under varying heads.

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UNIVERSITY OF OKLAHOMA.

(1012) (a) VOLUMETER RESEARCH WITH OIL.
(b) Determine factors for use in commercial measurements of oil.
(c) Cooperative research project sponsored by the Special Research Committee on Fluid Meters of the American Society of Mechanical Engineers.
(d) Professor E. E. Ambrosius.
(e) Professor E. E. Ambrosius.
(f) The performance of volumeters as to accuracy, viscosity, and rate-of-wear will be studied when measuring oil.
(g) Meter registration checked against weigh tank readings. This being done for all makes of meters under test, about thirty in number. Variable rates of flow used with variable temperatures. Four oils with different viscosity indices to be used. Flow rates up to 500 gpm to be used.
(h) Test work well started.

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THE PANAMA CANAL HYDRAULICS LABORATORY.

(1013) (a) MANIFOLD RESEARCH.
(b) The Panama Canal new locks project.
(c) Apparatus designed to study manifold action. The relations between individual port discharge and the following will be studied:
(1) Differential head on the port.
(2) Velocity past the port.
(3) Ratio of port to tunnel area.
(4) Port shape.
(5) Port spacing.
(d) The Hydraulic Section personnel under the supervision of F. W. Edwards, Hydraulic Engineer.
(e) The Governor, The Panama Canal.
(f) The purpose of the investigation is to develop methods for use in the design of the hydraulic systems for the proposed additional locks for The Panama Canal.
(g) Initial apparatus consists of conduit sections of sheet metal and pyralin, 6 inches square, connected to a centrifugal pump. A single port installed in the pyralin section connects to a tank made of sheet metal and pyralin. The water surface elevation in the tank may be controlled at various levels. Ports of various sizes may be inserted between the conduit and the tank. Provisions are made for regulating the discharge past the port and for measuring the discharge from the conduit and from the port tank. The port can be used either for simulating an outlet or an inlet port. The apparatus is to be extended to include additional ports, each with a separate tank, in order to study the distribution of port discharges for various conditions. Pressures, velocities, and direction of flow at numerous points will be observed.
(h) Initial apparatus completed and installation started.

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THE UNIVERSITY OF PENNSYLVANIA.

(1014) (a) EFFECT OF INSTALLATION ON COEFFICIENTS OF VENTURI METERS.
(b) For general information.
(c) Four Venturi Tubes - 8x6 inches, 8x5 inches, 8x4 inches, and 8x3-3/8 inches, being used.
(d) Prof. W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) To complete information started in A.S.M.E. Trans., November 1936 and November 1937.
(g) Weighed water tests of high accuracy, about 120 in all.
(h) About half done.
(i) Work being done for final inclusion in Fluid Meters Report, A.S.M.E.

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(1015) (a) FLOW CHARACTERISTICS OF ROUGH AND SMOOTH-BORE DOCK LOADING HOSE, 6" and 8" DIAMETER.
(b) E. I. du Pont de Nemours and Company, Inc.
(c) Tests to obtain friction factors "f" of 6" and 8" smooth and rough-bore hose, straight and bent.
(d) Prof. W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) To obtain "f"
(g) "f" plotted in terms of Reynolds Number from 10,000 to 1,000,000.
(h) Completed.
(i) Published by E. I. du Pont and Company.

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(1016) (a) CALIBRATION OF THREE SIMPLEX VENTURI TUBES - 14" x 9½", 10" x 5" and 6" x 3".
(b) U. S. War Department, Bonneville Hydraulic Laboratory, Bonneville, Oregon.
(c) Determination of coefficients to be used in above laboratory.
(d) Prof. W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) Under (c)
(g) Weighed water tests from 1 to 40'/" throat velocity.
(h) Completed.
(i) These Venturi tubes to be used for discharge measurement in connection with work of the above laboratory.

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(1017) (a) CALIBRATION OF FOUR SIMPLEX VENTURI TUBES - 22" x 11", 12" x 6½", 8" x 4" and 5" x 2½".
(b) Canadian National Hydraulic Laboratory, Ottawa, Canada.
(c) Determination of coefficients to be used in above laboratory.
(d) Prof. W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) Under (c)
(g) Weighed water tests from 1 to 40'/" throat velocity.
(h) Completed.
(i) These Venturi Tubes to be used for discharge measurement in connection with work in the above laboratory.

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RENSSELAER POLYTECHNIC INSTITUTE.

(887) (a) THE INVESTIGATION OF THE USE OF A DIAPHRAGM IN THE PRESSURE-MEASURING DEVICE OF A PARSHALL FLUME.
(b) General scientific research.
(c) Undergraduate thesis.
(d) Roy James Scovill, Jr..
(e) Grant K. Palsgrove, Professor of Hydraulic Engineering
(f) Further studies of the characteristics of a flexible diaphragm used in the pressure measuring device of a Parshall flume.

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(g) For this part of the investigation the flexible diaphragm was placed in a vertical position at the side of the channel of approach.
(h) Continuation of Project 687 reported in National Bureau of Standards Hydraulic Laboratory Bulletin, Series A, Bulletin VII, January 1939. Project incomplete; part herein reported available at Rensselaer Polytechnic Institute Library.

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(1018) (a) EXPERIMENTAL DETERMINATION OF THE EFFECT OF BUCKET-WHEEL DESIGN ON THE RATING OF A SMALL PRICE WATER CURRENT METER.
(b) Cooperative project - Rensselaer Polytechnic Institute Department of Hydraulic Research and the W. & L. E. Gurley Company.
(c) Undergraduate thesis.
(d) Edwin Ford Clark.
(e) Grant K. Palsgrove, Professor of Hydraulic Engineering.
(f) To determine the characteristics of existing and experimental designs of bucket wheels on a small Price current meter for the purpose of pointing the way toward a more accurate and consistent meter rating at low water velocities.
(g) Test apparatus consisted of a tangent rating basin, 96 feet long, with a water cross section 3.5 feet square; a manually operated car spanning the flume; an electric clock; a tachometer; and a chronograph arranged to register time, meter revolutions and distance travelled by the car. A small Price current meter made by the W. & L. E. Gurley Co., Troy, N. Y., was used for all test work. It was suspended from a rigid rod attached to the car and placed with center line of meter 24 inches below the water surface. Different bucket wheels were designed and constructed and were placed in this meter. Their respective ratings were determined at suitable velocities for giving their complete characteristics. Rating and slip curves were plotted for all designs tested. Separate tests were conducted to determine the effect of pivot wear and pivot location on meter performance. In addition, different types of rods were used to support the meter, all in an attempt to determine the relative importance of these several factors on meter performance.
(h) Project incomplete; part herein reported available at Rensselaer Polytechnic Institute Library.
(i) Hemispherical and parabolic bucket shapes point to better performance than the standard bucket. Except for very low velocities, condition of pivot point has little effect on performance. Type of rod suspension has little effect except at high velocities. Further studies in progress.

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STANFORD UNIVERSITY.

(1019) (a) STEEP SLOPE FLOW PHENOMENA.
(b) Research.
(c) Research.
(d) Dr. W. F. Durant, J. Hedberg.
(e) Prof. J. Hedberg.
(f) To determine length-velocity relationship and obtain characteristics of roller waves.
(g) A nine-inch wide redwood channel 40 feet long has an adjustable slope. Flow is regulated with orifice meter.
(h) Measurements of flow and depths along the channel now being made.

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(1020) (a) FLOW OF FLUIDS IN FRACTIONATING COLUMNS.
(b) Standard Oil Company of California.
(c) Graduate thesis.
(d) C. B. Lusk.
(e) J. Hedberg.
(f) To determine most effective weir, best spacing of bubble caps, and proper slope of trays.
(g) A full scale reproduction of $\frac{1}{4}$ of a tray is to be fitted with various weir crests and spacing of caps. Air bubbling through water is to simulate operating conditions.
(h) In construction stages.

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UNIVERSITY OF TEXAS.

(1021) (a) AN INVESTIGATION OF MINIMUM SEWER GRADES.
(b) Graduate thesis.
(c) Laboratory research.
(d) Jack Neal.
(e) Quintin B. Graves.
(f) To determine the practicability of the practice of permitting the use of a larger pipe at a smaller grade than may be used with a conventionally designed size and grade.
(g) Work just getting under way.

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UNIVERSITY OF WISCONSIN.

(764) (a) EFFECT OF VISCOSITY AND SURFACE TENSION ON V-NOTCH WEIR COEFFICIENTS.
(c) Doctor's thesis.
(e) Professor Arno T. Lenz.
(h) Continuation of project previously reported.

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(768) (a) STANDARD WEIR AND ORIFICE STUDIES.
(c) Departmental research project in cooperation with the Graduate School.
(e) Professor J. G. Woodburn.
(h) Continuation and extension of Standard Weir Studies previously reported.

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(903) (a) RELIEF FROM WATER HAMMER IN SMALL COMPOUND PIPES.
(c) Undergraduate theses.
(e) Professor L. H. Kessler.
(h) Continuation of work previously reported.

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(1022) (a) FLOW OF LIQUIDS IN OPEN CHANNELS.
(b) Ph. D. Thesis.
(c) Ph. D. Thesis.
(d) E. R. Dodge.
(e) Professor J. G. Woodburn.
(f) To investigate the physical nature and the applicability of empirical formulas for flow in open channels.
(g) Investigations are to be made of uniform flow of water in a wood channel of 7 in. x 12 in. cross section, 80 ft long. Flows with channel bed slopes of 0.0005 to 0.0100 are to be produced. Photographic methods are planned to ascertain the physical nature of flow. It is hoped to perform experiments on liquids other than water.
(h) Data have been collected with uniform flows in the wood channel for bed slopes of 0.0005 to 0.01. These tests are being repeated to check and supplement the data obtained. Preliminary designs have been prepared for a glass-lined flume 6 in. by 10 in. in cross section and 40 ft long for experiments on water and other liquids.

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(1023) (a) FASTER UNLOADING OF OIL-TRUCK TANKS.
(b) Flow Test Committee of the National Truck Tank Association, Chicago, Ill.
(c) Experimental investigation of the flow of liquids through valves, meters, fittings and apparatus used by the Truck Tank Industry.
(d) L. H. Kessler, Director, R. Stiemke, R. Zwettler, Research Assistants.
(e) Professor L. H. Kessler.
(f) To obtain data for publication of a manual for design of the distribution piping systems of truck tanks.
(g) Pipes meters, valves and fittings of nominal 2", $2\frac{1}{2}$", and 3" sizes will be tested with water, Stoddard Solvent, fuel oil, and gasoline to determine the friction loss in each device. A portion of the laboratory has been reconstructed so as to provide a recirculation system including elevated tank, storage and pump sumps, and weighing tank.

(h) The construction of the special laboratory has been completed, and tests are under way on the iron pipes and steel tubing, cross valves, "T" fittings, and elbows.
(i) All data will be released first through the National Truck Tank Association who will transmit it to the various manufacturers cooperating. Final decision has not been made as to the type of publication.

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UNIVERSITY OF IOWA.

(316) (a) HYDROLOGIC STUDIES - RALSTON CREEK WATERSHED.
(b) and (c) Co-operative project - Iowa Institute of Hydraulic Research, U. S. Department of Agriculture, and U. S. Geological Survey.
(e) Prof. J.W.Howe.
(h) Continuous records since 1924 of precipitation, runoff, ground-water levels, and cover. Drainage area 3 sq miles of rolling agricultural land near east city limits of Iowa City.

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(317) (a) CO-OPERATIVE STREAM GAGING IN IOWA.
(b) Iowa Institute of Hydraulic Research.
(c) Co-operative project - U. S. Geological Survey.
(d) R. G. Kasel, District Engineer, and staff.
(e) R. G. Kasel.
(h) Stream gaging stations are maintained co-operatively, at stations on major watersheds in Iowa.

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(844) (a) STUDY OF EVAPORATION FROM LAKE SURFACES.
(b) Co-operative project, U. S. Weather Bureau, Iowa Lakeside Laboratory, and Iowa Institute of Hydraulic Research.
(c) Observations of evaporation under various conditions at Lake Okoboji, Iowa.
(d) Staff members of co-operating parties.
(e) B. S. Barnes.
(f) To determine the laws governing evaporation from water surfaces of lakes under various conditions.
(g) Extensive observations on evaporation and controlling hydrological conditions will be made on lakes centering around Lake Okoboji, for a wide variation of conditions such as size, depth, etc.
(h) Studies are just begun, observations with standard and insulated pans at edge of Lake Okoboji under way.

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(845) (a) STUDY OF HYDROLOGY OF RAPID CREEK.
(b) Co-operative project - U. S. Geological Survey, U. S. Weather Bureau, and Iowa Institute of Hydraulic Research.
(c) Development of index basin for vicinity of Iowa City.
(d) Staffs of co-operating parties.
(e) Iowa Institute of Hydraulic Research.

(f) To develop the relation between rainfall and stream flow as an aid in predicting the flood flows of larger streams.
(g) Measurements of stream flow, rainfall, and groundwater level will be observed and correlated.
(h) Stream flow measurements under way, rainfall and groundwater observing stations about to be installed.

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(846) (a) HYDROLOGIC STUDIES - BASINS OF UPPER MISSISSIPPI REGION.
(b) Iowa Institute of Hydraulic Research.
(c) Co-operative project - U. S. Weather Bureau.
(d) B. S. Barnes, Hydrologic Supervisor, Upper Mississippi Region, and staff.
(e) B. S. Barnes.
(f) To determine the relation between precipitation and runoff, and particularly the form of discharge hydrograph resulting from a given rainfall, with a view to the more accurate prediction of daily river stages.
(g) Study of climatological records, construction and analysis of discharge hydrographs, especially of the smaller basins. Field studies include the obtaining of records of momentary rainfall intensities and some special evaporation experiments.

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(595) (a) A STUDY OF THE LAWS OF TRANSPORTATION OF SEDIMENT BY FLOWING WATER.
(b) Co-operative project, Iowa Institute of Hydraulic Research and various government agencies.
(c) Project includes collection and analysis of sediment from a wide variety of streams and the analysis of sediment data obtained by other agencies with a view to developing the laws governing the transportation of material by streams, the manner of deposition in reservoirs and other engineering problems related to sediment transportation.
(d) Iowa Institute of Hydraulic Research and co-operating government agencies.
(e) Prof. E. W. Lane.
(f) The purpose of the investigation is to develop methods by which the engineering problems related to sediment transportation can be solved in a quantitative way.
(g) Sediment samples from a number of streams have been collected and analyzed and deductions on the laws of transportation derived from the results. Laboratory and field studies are planned of the laws governing transportation of material in suspension. The method of deposition in reservoirs and other engineering aspects will be studied.
(h) The study has been under way about three years, and a progress report is planned during the coming year.

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(847) (a) THE SHAPE OF STABLE CHANNELS.
(b) Department of Mechanics and Hydraulics.
(c) Master's Thesis.
(d) E. W. Lane, C. J. Posey, and C. T. Li.
(e) Prof. E. W. Lane.
(f) To develop the laws governing the shape of water-conveying channels in erodible material.
(g) A study will be made of the shape of actual channels covering a wide range of conditions to determine the laws governing both cross section and alignment.
(h) Studies being continued.

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(846) (a) SPREADING OF A WATER JET ON A LEVEL FLAT FLOOR.
(b) Department of Mechanics and Hydraulics.
(c) Master's Thesis (experimental)
(d) E. Muratzade.
(e) Prof. E. W. Lane.
(f) To study the rate of spread of water flowing on a flat floor at high velocity.
(g) Measured cross-sections of a rectangular jet on flat floor without sides, at various distances from the orifice. Jets with ratios of height to width from 3:1 to 1/4:1 were tested.
(h) Thesis completed - (See abstract in this Bulletin).

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(1024) (a) TRANSITIONS IN RECTANGULAR OPEN CHANNELS WITH SUPER-CRITICAL VELOCITIES.
(b) Department of Mechanics and Hydraulics.
(c) Doctor's thesis (experimental)
(d) Warren Wilson.
(e) Prof. E. W. Lane.
(f) To determine the condition of flow in rectangular channel transitions - with super-critical velocities, to assist in the design of structures.
(g) Observations were made of the waves formed and the permissible rate of spread of side walls.
(h) Laboratory work completed, report being prepared.

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(1025) (a) STUDY OF EQUIPMENT AND TECHNIQUE FOR SUSPENDED SEDIMENT SAMPLING AND ANALYSIS.
(b) U. S. Departments of War, Interior, Agriculture, Tennessee Valley Authority, and Iowa Institute of Hydraulic Research.
(c) A study will be made to determine the errors resulting from present methods and equipment of sediment sampling and to devise means of reducing them. An investigation of present methods of sediment concentration and size analysis will also be carried out and the possibility of improved methods will be studied.
(d) U. S. Departments of War, Interior, Agriculture, Tennessee Valley Authority, and Institute of Hydraulic Research.
(e) Prof. E. W. Lane.

(f) To increase accuracy and reduce cost of sediment sampling and analysis.
(g) Review of present status of suspended sediment-sampling equipment, field technique, and laboratory analysis, with office and laboratory studies of the errors involved and the possibility of developing improved methods and equipment.
(h) Report on present status of suspended sediment-sampling equipment and technique soon to be completed.

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(849) (a) AN INVESTIGATION OF FISHWAYS.
(b) Iowa Institute of Hydraulic Research in co-operation with Iowa Conservation Commission.
(c) Library and laboratory research.
(d) A. M. McLeod and Dr. Paul Nemenyi.
(e) E. W. Lane.
(f) To develop more effective and economical fishways.
(g) Models about 8 x 8 inches in cross-section and 5 ft in length were studied both as to their hydraulics and as to their ability to pass small fish. Full size fishways were installed at the Laboratory dam for a comparison of various designs, checking results of model tests, and collecting data for a study of the migratory habits of fish.
(h) The first stage of all studies mentioned has been completed, and a preliminary report is being prepared. Further investigations are planned.

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(743) (a) SIMULTANEOUS FLOW OF AIR AND WATER IN CLOSED CONDUITS.
(b) Iowa Institute of Hydraulic Research in co-operation with Committee on Hydraulic Research, American Society of Civil Engineers.
(c) Laboratory research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Dean F. M. Dawson.
(f) To obtain data on the flow of water in partly full conduits when air is being dragged along, when the air is flowing faster than the water, and when the air flows counter to the direction of the water.
(g) A rectangular closed conduit 8" x 7" by 50 ft long is used with transparent sides. Provisions for air flow measurement will be made at both ends of the conduit. Surface friction between the air and water is one of the important items to be investigated.
(h) Tests are now being made.

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(850) (a) HYDRAULICS AND PNEUMATICS OF PLUMBING DRAINAGE SYSTEM.
(b) Iowa Institute of Hydraulic Research in co-operation with the National Association of Master Plumbers.
(c) Laboratory and field research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Dean F. M. Dawson.

(f) To obtain basic data for sizing of drains, stacks, and vents of plumbing drainage system.
(g) Data obtained to be used in preparing tables and charts for use in plumbing codes.
(h) Results are published in Technical Bulletin No. 2 of National Association of Master Plumbers, 917 Fifteenth Street, N. W., Washington, D. C.

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(851) (a) HYDRAULICS OF VERTICAL DRAIN AND OVERFLOW PIPES.
(b) Iowa Institute of Hydraulic Research in co-operation with the National Association of Master Plumbers.
(c) Laboratory research.
(d) A. A. Kalinske and W. M. Wachter.
(e) Dean F. M. Dawson or A. A. Kalinske.
(f) To determine head-discharge relationship for various sizes and lengths of vertical drain pipes and overflow pipes which do not flow full. Air-flow measurements are also to be made.
(g) An apparatus has been constructed which will insure radial flow into pipes of diameters ranging from 6 inches to one inch.
(h) Tests are in progress and will be completed this year.

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(853) (a) AIR-CHAMBERS FOR WATER-HAMMER RELIEF.
(b) Iowa Institute of Hydraulic Research in co-operation with the National Association of Master Plumbers.
(c) Laboratory research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) A. A. Kalinske.
(f) To determine a relation between water velocity, pipe size, air-chamber volume, length of pipe, and water-hammer pressure reduction.
(g) All the variables mentioned in (f) are being varied for a simple straight pipe. Compound and branched pipes are also to be studied. A high-speed Diesel engine indicator of the cantilever spring type is used to record the pressures.
(h) Tests are being continued. Some of the results were published in a paper "Methods of Calculating Water-Hammer Pressures", Jour. of Amer. Water Works, Vol. 31, Nov. 1939, p. 1835.

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(855) (a) DIFFUSION CHARACTERISTICS OF TURBULENCE IN AN OPEN CHANNEL.
(b) Iowa Institute of Hydraulic Research.
(c) Master's Thesis.
(d) A. A. Kalinske and J. M. Robertson.
(e) A. A. Kalinske.
(f) The purpose of this investigation is to study the variation of the coefficient of turbulent diffusion vertically in an open channel by direct experimental means.
(g) The diffusion coefficient is to be determined from data obtained by means of motion pictures of the spread of immiscible liquid droplets injected into the water stream. The experiments will be made in a 2.5 foot channel with different water depths and with a variation of bottom roughness.

(h) Thesis completed. (See abstract in this Bulletin.)

(507) (a) THE CONVERSION OF KINETIC INTO POTENTIAL ENERGY.
(b) Iowa Institute of Hydraulic Research in co-operation with the Am. Soc. C. E. Committee on Hydraulic Research.
(c) Independent research.
(d) A. A. Kalinske.
(e) Prof. F. T. Mavis, Pennsylvania State College, State College, Pennsylvania.
(f) To investigate the basic physical phenomena of flow in divergent conduits with particular reference to the conversion of energy.
(h) Analysis of laboratory experiments in progress.

(1026) (a) TURBULENCE AND SUSPENDED MATERIAL TRANSPORTATION IN A SMALL OPEN CHANNEL.
(b) Iowa Institute of Hydraulic Research.
(c) Laboratory research.
(d) A. A. Kalinske, J. M. Robertson, C. L. Pien.
(e) A. A. Kalinske.
(f) To measure the diffusion characteristics of water flowing in an open channel, and to correlate such data with observations on suspended material transportation. The channel being used is 11 inches wide, 10 inches deep, and 70 feet long.
(g) The photographic technique for determining the diffusion characteristics of turbulence that was developed in Project 855 will be used in this project. It is planned to use material lighter than sand in order to get suspension at velocities of about 2 to 5 feet per second.
(h) The apparatus is complete, and the preliminary experiments have begun.

(1027) (a) INVESTIGATION OF OPERATION OF GREASE INTERCEPTORS.
(b) Iowa Institute of Hydraulic Research in co-operation with the National Association of Master Plumbers.
(c) Laboratory Research.
(d) Dean F. M. Dawson, A. A. Kalinske, A. M. McLeod.
(e) Dean F. M. Dawson.
(f) To determine the basic principles of grease interceptor design.
(g) Tests are being made on various types of commercial grease interceptors. Later a more fundamental study is to be made on the effect of baffles, water turbulence, and water velocity on the carrying of particles lighter and heavier than water, such as the grease and solids which ordinarily enter an interceptor.

(1028) (a) DESIGN OF WATER-SUPPLY SYSTEMS FOR BUILDINGS.
(b) Iowa Institute of Hydraulic Research in co-operation with the National Association of Master Plumbers.
(c) Library and Laboratory Investigation.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Dean F. M. Dawson.
(f) and (g) To compile and organize all existing data on friction loss in iron, lead, and copper pipe and for all types of fittings and plumbing fixtures. This data is to be used in developing simplified methods of water-piping sizing for plumbing systems. Laboratory tests will be made on those fittings or fixtures for which data is not available.
(h) The library investigation has begun.

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(1029) (a) DETERMINATION OF BEST PROPORTIONS FOR CANAL BENDS.
(b) Department of Mechanics and Hydraulics.
(c) Doctor's thesis (experimental)
(d) Chen-Hsing Yen.
(e) Prof. J. W. Howe.
(f) To determine effect of different proportions of cross-section upon losses in bends.
(g) Experimental flume, one foot square in cross-section, about 90 feet long, containing 90° bend, to be tested under various slopes, depths, and proportions of cross-section.
(h) Beginning.

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(856) (a) HYDRAULICS OF CULVERTS.
(b) Department of Mechanics and Hydraulics.
(c) Graduate thesis (library and experimental).
(d) Prof. F. T. Mavis, and A. R. Luecker.
(e) E. W. Lane.
(f) To review flow data and test reports, and to study effects of systematic entrance variations.
(g) Tests of transparent model conduit with submerged and free outlets.
(h) Thesis completed, see abstract in this Bulletin.

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(859) (a) EFFECT OF FREE BOARD UPON EVAPORATION FROM STANDARD LAND PAN.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis (experimental).
(d) Russell W. Revell.
(e) Prof. J. W. Howe.
(g) Level in two land pans held constant by Marriotte flask apparatus. Both pans given same exposure but operated with different free boards. Air and water temperatures, relative humidity, wind velocity over the pan, and evaporation observed.
(h) Data have been secured.

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(1030) (a) SEDIMENT BEHAVIOR IN UPWARD FLOW.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis. (experimental research).
(d) W. W. DeLapp.
(e) Prof. H. Rouse.
(f) To determine the variation of sediment concentration in upward flow for conditions ranging between the limits of percolation and suspension.
(g) Tests will be made in a 12-inch glass cylinder 19 inches in height, using various grades of sand. For each material the concentration will be studied as a function of elevation and velocity of flow.
(h) Apparatus now under construction.

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(1031) (a) (STRUCTURAL) TESTS OF FLUME CORNERS.
(b) Department of Mechanics and Hydraulics.
(c) Research, including Master's thesis.
(d) C. J. Posey and O. Nefoid.
(e) C. J. Posey.
(f) To find most satisfactory design for flume corners which are subject to tension on the inside.
(g) Tension tests of knees with V and M similar to actual values in flumes.
(h) Designs being prepared in light of results by previous investigators.

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(1032) (a) EFFECTS OF CERTAIN FLUID PROPERTIES UPON THE PROFILE OF THE HYDRAULIC JUMP.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis.
(d) C. J. Posey, M. D. Dubrow, J. C. Goodrum.
(e) C. J. Posey.
(f) To study effect of viscosity and surface tension on the profile of the jump.
(g) Various fluids in recirculating hydraulic demonstration table.
(h) Designing experiments correcting defects in apparatus which had been previously used for other projects.

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(1033) (a) INTEGRATED STUDY OF PROPULSION OF GRANULAR MATERIALS BY FLUIDS IN TURBULENT FLOW.
(b) Iowa Institute of Hydraulic Research.
(c) Survey and research.
(d) Paul Nemenyi.
(e) Dr. Paul Nemenyi.
(f) Unification of the various physical, geophysical (hydro/and aerological), geomorphologic, and civil engineering studies and results relevant for the problem.
(g) The method of the study is primarily survey, dimensional analysis, and comparison. It is intended to find the main dimensionless variables common to all phenomena in question as distinguished from the specific variables (as e.g. slope and "form factors" for the river problems.) The limits within which these variables are competent will be discussed. Controversies will be clarified by determining the limits of validity

for the different contradicting statements; for the decision of certain controversial issues special experiments will be proposed.

(h) A paper giving a general outline of the problem, especially of its methodical aspects, is being completed; a summary of it has been submitted to the Round-Table Discussion on The Role of Hydraulic Laboratories in Geophysical Research (Sept. 1939) under the title "The Different Approaches to the Study of Propulsion of Granular Materials and the Value of their Coordination".

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(1034) (a) SECONDARY CURRENTS IN STRAIGHT OPEN CHANNELS.
(b) Iowa Institute of Hydraulic Research.
(c) Experimental research.
(d) Paul Nemenyi.
(e) Dr. Paul Nemenyi.
(f) Exploration of types of secondary currents for a variety of cross-sections, different slopes, roughnesses, and regimes of flow. A qualitative theoretical explanation will be attempted. Also the analogous phenomena in closed conduits will be examined. Possible applications to river and channel engineering will be considered.
(g) The experimental work will be mostly observational, however some quantitative measurements will be made. The observed secondary currents will be correlated with measured distributions of longitudinal velocity.
(h) A comparative examination of existing observations and opinions has been made. The experimental work is being started.

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(860) (a) MISSISSIPPI RIVER SUBMERGIBLE TAINTER LOCK GATES FOR ST. ANTHONY FALLS LOCKS, MINNEAPOLIS, MINN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To study hydraulic conditions in the locks when the chambers are filled by means of submergible Tainter gates which also replace the conventional upstream miter gates. The Tainter gate will be used also for passing flood discharge.
(g) Tests are being conducted in a model on a scale of 1 to 23.4; observations are made with respect to turbulence, surging, hawser pull, and duration of lockage. A 1/7th size model of a section of submergible Tainter gate was set up to study crest shapes.
(h) A complete lock model was tested with various gate operation schedules until the one causing minimum mooring hawser stress could be determined. From studies on the large-scale gate model, designs have been developed for the shape of gate.

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(861) (a) MISSISSIPPI RIVER, FILLING AND EMPTYING SYSTEM FOR NEW LOCK NO. 2, HASTINGS, MINN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a satisfactory system to fill and empty the lock, employing short culverts around the lock gates.
(g) Tests are being conducted in a model on a scale of 1 to 30; observations are made with respect to turbulence, surging, hawser pull, and duration of lockage.
(h) Tests have supplied a sufficient amount of data on the stub culvert system. The project was expanded to include tests on side culverts and ports extending the length of the model, and tests were made on such a system with uniformly spaced ports.
(i) Automatic recording apparatus is now under construction.

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(862) (a) MISSISSIPPI RIVER, FILLING AND EMPTYING SYSTEM FOR NEW LOCK NO. 19, KEOKUK, IOWA.
(b) Corps of Engineers, U. S. Army, Rock Island District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a satisfactory system to fill and empty the lock, employing (1) culverts and ports in the floor of the lock chamber, or (2) short culverts in the upper and lower gate sills, or (3) a filling system using a combination of submergible Tainter gate and short sill culverts, and an emptying system with short culverts under the lower gate sill.
(g) Tests are being conducted in a model on a scale of 1 to 24, simulating the various types of filling systems proposed and observing turbulence, surging, hawser pull, and duration of lockage.
(h) Several filling systems which included sill culverts, floor culverts, and submergible Tainter gate were tested. While each system had merits, the most generally favorable filling characteristics were obtained with the Tainter gate used as upper lock gate.

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(1035) (a) PROTOTYPE LOCK HYDRAULICS TESTS TO VERIFY MODEL EXPERIMENTS.
(b) Corps of Engineers, U. S. Army, Ohio River Division.
(c) See title.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To obtain data on the filling and emptying characteristics of navigation locks in the Ohio River Division and to observe navigation conditions in the lock approaches and flow conditions in dam stilling basins for comparison with similar model and prototype data.

(g) Rates of filling and emptying and pressure changes in culverts and ports were observed on special pneumatic manometers. Velocities at the lock chamber ends of filling and emptying ports were measured by means of a pitot bar. Measurements were made at several locks in the Tennessee and Ohio Rivers.
(h) Tests are complete and a report is being prepared.

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(1036) (a) DISCHARGE COEFFICIENTS FOR OBSTRUCTIONS TO SUPER-FLOOD FLOWS.
(b) Corps of Engineers, U. S. Army, Rock Island District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To evaluate the obstruction offered to super-flood flows by bridges, dams, river walls, and other contractions in river channels.
(g) A generalized model of a river reach with a tributary has been constructed 1/120th prototype size. A number of bridges of various types will be installed in it and tested at depths submerging the decks. City conditions will be simulated on the overbank areas.
(h) The basic model has been built.

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(1037) (a) MISSISSIPPI RIVER, NAVIGATION CONDITIONS IN UPSTREAM APPROACH TO L/D NO. 6, TREMPEALEAU, WISCONSIN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To determine what corrective measures can be used economically and effectively to eliminate hazardous currents in the upstream lock approach channel and to prevent excessive scour now taking place at the upstream end of the river wall of the auxiliary lock.
(g) Tests are being conducted on a model 1/80th prototype size simulating a reach of the Mississippi River with Lock & Dam No. 6 at the downstream end.
(h) Wing dams upstream from the lock, submerged sills in the upper lock approach, and permeable guard walls have been studied as possible means of improving navigation conditions. Investigation of scour conditions is now under way.

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(1038) (a) DIVERSION CHANNEL STILLING BASIN, DRY RUN FLOOD CONTROL PROJECT, DECORAH, IOWA.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a suitable stilling basin above the outlet of the proposed Dry Run Diversion Channel.
(g) A model, scale 1/50, was constructed of lumber and sheet iron to simulate the proposed channel sections. Piezometers were provided to measure water pressures at various points.
(h) Tests are in progress.

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PACIFIC HYDROLOGIC LABORATORY.

(752) (a) STUDY OF REMOVAL OF SALT WATER FROM DREDGER FILL BY DRAINAGE AND LEACHING.
(b) Golden Gate International Exposition, Department of Works, Treasure Island, San Francisco, California.
(c)(d)(e)(f)(g) (See complete report of this project in earlier bulletins.)
(h) After a lapse of 18 months, including the entire Exposition Period, no injury from or indication of the presence of salinity in the soil has been noted in any vegetation planted at Treasure Island, including trees, shrubs and annuals.
(i) Additional published reports describing this project have been issued as follows: (1) Drainage & Leaching at Treasure Island, Charles H. Lee; Proceedings American Road Builders Association, 1939 Convention at San Francisco, Calif. (2) Record well-point installation used to drain Exposition site; Western Construction News, June, 1938. (3) Testing Program used to Determine Treasure Island Drainage Procedure, Charles H. Lee, Western Construction News, July 1939.

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(916) (a) STUDY OF INCREASING THE IMPERMEABILITY OF CLAY MEMBRANE BY USE OF SODIUM CHLORIDE.
(b) Golden Gate International Exposition, Department of Works, Treasure Island, San Francisco, Calif.
(c)(d)(e)(f)(g) (See complete report of this project in earlier bulletins.)
(h) As a result of the preliminary salt-water treatment, the clay lining of the lagoon at Treasure Island was entirely sealed within 90 days of the introduction of fresh water, following the salt-water treatment. An interesting phenomenon in connection with the sealing process was the escape of entrapped air during four low-pressure periods, accompanying general cyclonic storms. Within a period of two or three days during each of these storms, seepage loss through the clay membrane experienced a 30 to 50% reduction. The fourth storm, March 23 and 24, 1939, reduced the seepage to practically zero. As a result of sealing the lagoon, make-up water was needed only for replacing evaporation, and was relatively small in amount.

(i) Paper describing the experimental work and application of method developed has been submitted to the A.S.C.E., and will appear in "Proceedings", in the near future, under the title "Sealing the Clay Lining of the Lagoon at Treasure Island by Use of Sea Water", by Charles H. Lee.

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(1039) (a) HYDRAULIC-FILL DAM INVESTIGATION.
(b) The Livingood Placers, Inc.
(c) Conducted as part of engineering research for design and selection of material for hydraulic fill dam.
(d) Charles H. Lee.
(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.
(f) Study of physical properties of soil as related to hydraulic fill dam construction.
(g) Tests were made upon borrow pit samples as follows: Mechanical analysis by hydrometer method, specific gravity, shear, settling velocity of fines to determine division of material between beach, core and waste, progressive density of settled fines, etc. Test data were applied to selection of borrow pit material and setting up a construction program. The available material consists of weathered and decomposed chert, very deficient in sand and coarse silt, but with a thin overburden of silty top soil. Weather conditions are very severe, with freezing temperature eight months of the year, thus limiting the construction period to 125 days. These unusual conditions made necessary special consideration of the utility of the available materials to hydraulic fill construction.
(h) Laboratory tests completed. Construction work is planned for next summer.
(i) Report of tests and conclusions submitted to Livingood Placers. Preparation of technical paper awaits completion of construction.

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UNIVERSITY OF CALIFORNIA.

(426) (a) HYDRAULIC ROUGHNESS IN CLOSED CHANNELS.
(b) Laboratory research.
(c) Laboratory project.
(d) P. G. Folsom, F. Jonassen.
(e) Professor M. P. O'Brien.
(f) To study relationship between friction factor "f" and surface geometry at fully developed turbulence, using artificially roughened surfaces.
(g) The pressure drop is determined experimentally for air flowing through a rectangular redwood duct artificially roughened by means of grooves cut transversely to the flow. By changing the width of the duct, the relative roughness may be altered and the absolute roughness by increasing or decreasing the pitch of the grooves.
(h) Experiment completed. Report in progress.

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(634) (a) SAN DIMAS METERING FLUME.
(b) Cooperation with California Forest and Range Experiment Station.
(c) Laboratory Project.
(d) Wilm, Stoker, Bermel.
(e) Professor M. P. O'Brien.
(f) Calibration of metering flume under various conditions of bedslope, roughness, shape size.
(g) Tests on 6" flume have been completed, and tests are now in progress on a one-foot concrete flume. Tests will be extended to flow transporting bed-load.
(h) Construction of bed-load equipment now in progress. A discussion by R. L. Stoker describing these experiments appeared in the Proceedings of the American Society of Civil Engineers for June 1938.

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(720) (a) MODEL STUDY OF WAVE ACTION ON CABRILLO BEACH, CALIFORNIA.
(i) See abstract in this Bulletin.

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(723) (a) RECOVERY EFFICIENCY OF VARIOUS TYPES OF SLOWLY MOVING FLUID INTERFACES.
(b) Standard Oil Co. of California Research Fellowship.
(c) Laboratory project.
(d) R. L. Parsons.
(e) Professor M. P. O'Brien.
(f) To determine the most efficient type of representing media for oil recovery.
(g) Measure recovery of oil from a cylinder of oil-saturated sand for water and gas drives.
(h) Continuation of work of D. R. Rankin: See abstract in this Bulletin.

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(726) (a) PUMP TESTING LABORATORY.
(b) Laboratory investigations in cooperation with the College of Agriculture.
(c) L. S. Jue, R. G. Folsom, R. De Fries.
(d) Professor M. P. O'Brien.
(e) Research in the general field of pumping.
(f) Present investigations include:
1. Research in the field of deep-well and propeller pumps.
2. Analysis of laboratory and field methods of testing, development of test standards and calibration of test instruments.
3. Test of motors, bearings, and other auxiliary equipment.
4. Tests of manufacturers' types.
5. Tests on specific pumps and pump accessories and equipment.
(g) The equipment is in operation. See abstract in this Bulletin.

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(799) (a) EFFECT OF VISCOSITY UPON THE CHARACTERISTICS OF A CENTRIFUGAL PUMP.
(b) Laboratory project.
(c) Master's thesis.
(d) Nathaniel Van De Verg.
(e) Prof. M. P. O'Brien.
(f) To be able to predict the performance of a centrifugal pump pumping viscous fluids after obtaining the performance of the pump using water.
(g) Testing of 2" centrifugal pump using water and using two oils of different viscosity.
(h) Experimental work in progress.

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(800) (a) PRE-ROTATION IN PROPELLER PUMPS.
(b) Laboratory project.
(c) Master's thesis.
(d) Lawrence Sinclair Jue.
(e) Prof. M. P. O'Brien.
(f) To study the magnitude and direction of the water stream fore and aft of the runner in a propeller pump.
(g) A transverse pitometer with remote control will be used.
(h) Pitometer calibration complete. Experiment in progress.

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(a)
(801)/FRICTION LOSSES IN ANGULAR CONTACT THRUST BEARINGS.
(b) Laboratory investigation.
(c) Master's thesis.
(d) W. Johnson.
(e) Prof. M. P. O'Brien.
(f) To determine friction losses in angular contact thrust bearings under conditions of use in deep-well turbine pumps.
(g) To determine by tests:
(1) Friction of ball on race.
(2) Oil pumping losses.
(3) Losses due to misalignment.
(h) Experiments in progress. See abstract in this Bulletin.

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(802) (a) THE DESIGN OF A PROPELLER TURBINE.
(b) Laboratory project.
(c) Ph. D. Thesis.
(d) F. Jonassen.
(e) Prof. M. P. O'Brien.
(f) To predict the characteristics of a propeller turbine having airfoil-section blade shapes.
(g) Using a small vertical turbine, the predicted results will be checked experimentally. Effects of vertical blade interference will be studied, using a direction pitot-tube.
(h) Equipment assembled. Experiment in progress.

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(803) (a) MIXING OF STREAMS IN CLOSED CIRCULAR CONDUITS.
(b) In cooperation with Special Committee on Hydraulic Research, American Society of Civil Engineers.
(c) Master's thesis.
(d) E. H. Taylor, W. R. Shuler.
(e) Prof. M. P. O'Brien.
(f) To determine energy losses which result from the convergence or divergence of closed circular conduits.
(g) Tests will include determinations for angles of convergence or divergence of 30°, 45°, 60°, 90°, 135°, and 150°. Test set up consists of 2", 4", and 6" branch pipe joining a 6" diameter main line.
(h) Equipment is complete and testing is in progress. Continuation of work of Kempton and Hoefler. See abstract in this Bulletin.

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(804) (a) DISCHARGE CHARACTERISTICS OF RECTANGULAR SLUICE GATES.
(i) See abstract in this Bulletin.

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(806) (a) OSCILLATORY WAVES.
(i) See abstract in this Bulletin.

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(807) (a) TRANSPORTATION OF SAND IN PIPE LINES.
(i) See abstract in this Bulletin.

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(808) (a) MODEL STUDY OF PROPOSED TIDAL CANAL BETWEEN SUISUN BAY AND SACRAMENTO, CALIFORNIA.
(b) Laboratory project.
(c) Master's thesis.
(d) M. P. O'Brien, D. A. Elliget.
(e) Prof. M. P. O'Brien.
(f) To predict tidal effects in the proposed canal by a combination of experimental and theoretical studies.
(g) Model to be constructed of sheet metal to a scale of 1:500 horizontally and 1:100 vertically. Runs will be with various tidal amplitudes and heights, and velocities of the resultant waves will be measured.
(h) Experiments completed. Report in progress.

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(809) (a) CHARACTERISTICS OF SAND PUMPS.
(b) Laboratory project.
(c) Master's thesis.
(d) R. G. Folsom, L. C. Fairbank.
(e) Prof. M. P. O'Brien.
(f) To predict head-discharge characteristics of centrifugal pumps when pumping sand mixtures from the known characteristics when pumping water.
(g) A series of runs will be made using sand-water mixtures of various types of sand.
(h) Equipment complete and experimental work in progress.

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(1040) (a) DAMS ON PERVIOUS FOUNDATIONS.
(b) Laboratory project.
(c) Ph. D. thesis.
(d) M. A. Selim.
(e) Prof. M. P. O'Brien.
(f) Study of the percolation line and collection of data for empirical formulas for the length of the impervious floor.
(g) Use will be made of small-scale models.
(h) Equipment being designed.

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(1041) (a) TEST OF A JET AND CENTRIFUGAL PUMP COMBINATION.
(b) Laboratory project.
(c) Special study for senior students.
(d) R. A. Rhoda, R. G. Folsom.
(e) Prof. M. P. O'Brien.
(f) To determine the operating point of a jet and centrifugal pump combination.
(g) The equipment includes a standard 1-hp centrifugal pump, jet pump combination for a water-pressure system. Tests on this system will be used to check predicted results.
(h) Tests are in progress.

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(1042) (a) FLOW METER RATING FOR FLUIDS CARRYING SOLIDS IN SUSPENSION.
(b) Laboratory project.
(c) Special study for senior students.
(d) S. Werner, R. G. Folsom.
(e) Prof. M. P. O'Brien.
(f) To determine the coefficients to use with quantity-rate meters for measuring the flow of fluids containing small solid particles in suspension.
(g) Experimentally calibrate a meter of the Venturi type with sand-water mixtures of various concentrations and sand sizes, meters being in horizontal and vertical positions.
(h) Tests in progress. Preliminary work indicates that normal coefficients for water may be used for mixtures when the head is expressed in feet of mixture within certain limitations.

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(1043) (a) EQUILIBRIUM SAND SLOPES IN FRONT OF SEA WALLS.
(b) Laboratory project.
(c) Master's thesis.
(d) Lt. G. M. Dorland.
(e) Prof. M. P. O'Brien.
(f) To determine the effect of variable sand quantities on beach slopes in front of sea walls.
(g) This is a continuation of Lt. C. H. Waters' work carried forward to sea walls. A wave tank one foot wide by three feet deep is used, waves generated, and the run continued until equilibrium is reached. Runs will be made between quantity and slope. It is expected to use three grades of sand and to make about fifteen runs for each grade.
(h) Tank is set up and ready to operate .

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(1044) (a) MODEL STUDY OF WAVE REFRACTION.
(b) Laboratory project.
(c) Master's thesis.
(d) Lieut. W. P. McCrone, Lieut. E. E. Wilhoyt.
(e) Prof. M. P. O'Brien.
(f) To check experimentally the existing wave-refraction theories. To investigate refraction around islands and breakwaters in deep water.
(g) Experiments take place in a basin approximately 58' x 38' x 2' deep. A plunger-type wave machine located at one end creates the waves. Various sea-shore forms to be built in basin to study refraction. Movable platform used for taking pictures vertically from a height of 22 ft.
(h) All apparatus in place. First study of an ideal beach on 1:20 slope. Deep-water waves advance at an angle of 45° to beach. Tests on first model practically completed.

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(1045) (a) UNSTEADY FLOW OF FLUIDS THROUGH POROUS MEDIA.
(b) Laboratory project.
(c) Ph. D. Thesis.
(d) J. A. Putnam.
(e) Prof. M. P. O'Brien.
(f) To predict unsteady flow characteristics of porous media for homogeneous and non-homogeneous fluids.
(g) Using a linear channel filled with uniformly compacted sand, measurements will be made of the variation of pressure with time and space for various boundary conditions. Both homogeneous fluids and gas-liquid mixtures will be used.
(h) Apparatus for preliminary experiments now under construction.

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(1046) (a) AN INVESTIGATION OF THE HEAD LOSS THROUGH TRAPEZOIDAL-BAR FISH SCREENS.
(b) Laboratory project.
(c) Undergraduate thesis.
(d) Robert D. Smith.
(e) Prof. M. P. O'Brien.
(f) To determine the variation in the screen-head loss with the velocity, the depth of water, and the angle at which the screen is placed.
(g) The method consists of running various constant quantities of water through a rectangular steel channel, in which the screen has been installed with provision for varying its angle, and varying the depth and velocity by changing the position of a tail gate at the lower end of the channel.
(h) A complete set of tests has been run with the screen in the vertical position, and the results substantiate the premise that the head loss is a function of both the velocity and of the depth of flow. Similar tests will be run with the screen at an angle of 26° 34' as set in field practice to determine the effect of varying the angle.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY. Hydraulic Machinery Laboratory.

(36) (a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENA.
(b) Massachusetts Institute of Technology.
(c) General research.
(d) H. Peters, B. G. Rightmire.
(e) B. G. Rightmire.
(f) 1. Study of the factors which influence the severity of cavitation damage.
2. Study of the periodic nature of cavitation.
(g) Cavitation is produced by high acceleration of material or liquid by means of a magneto-striction vibrator.
(h) Progress reports:-
J. C. Hunsaker, Mechanical Engineering, April 1935, Vol. 57, No.4.
J. C. Hunsaker, Trans. A.S.M.E., October 1935, Vol. 57, No. 7.
E. W. Spannhake, Thesis, Massachusetts Institute of Technology Library, "Theoretical investigation of the periodic nature of cavitation".
Schumb, Peters, Millikan, Metals and Alloys, May 1937.
S. Logan Kerr, Trans. A.S.M.E., July 1937, Vol. 59, No. 5.
H. Peters, B. G. Rightmire, Proceedings Fifth International Congress for Applied Mechanics, 1939.

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(1047) (a) A STUDY OF BOUNDARY LAYERS.
(b) Massachusetts Institute of Technology and the National Advisory Committee for Aeronautics.
(c) Study of the nature and effects of fluctuations of velocity in the boundary layer.
(d) H. Peters, C. W. Jacob.
(e) J. Bickmell.
(f) As in (c).
(g) Measurement of velocity fluctuations with a hot-wire anemometer in a rectangular-section open-return wind tunnel.
(h) Investigation completed.
(i) Paper given before the Fifth International Congress of Applied Mechanics by H. Peters. Also Progress Report to the National Advisory Committee for Aeronautics. March 1939.

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(1048) (a) LAMINAR FRICTIONAL RESISTANCE WITH PRESSURE GRADIENT.
(b) Massachusetts Institute of Technology and the National Advisory Committee for Aeronautics.
(c) See (a).
(d) E. A. Wright, G. W. Bailey.
(e) J. Bickmell.
(f) See (a).
(g) Measurement of velocities in the boundary layer on a wall of a rectangular-section open-return wind tunnel.
(h) Investigation completed.
(i) Master of Science thesis submitted in May 1939, also paper "Laminar Frictional Resistance with Pressure Gradient" in Journal of the Aeronautical Sciences, Vol. 6, No. 12, October 1939.

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(1049) (a) STUDY OF HEAT TRANSFER ON BOUNDARY LAYER. SKIN FRICTION AND TRANSITION.
(b) Massachusetts Institute of Technology and the National Advisory Committee for Aeronautics.
(c) See (a).
(d) L. Lees.
(e) J. Bicknell.
(f) To determine the effects of heat transfer on the skin friction of laminar and turbulent boundary layers and on the stability of the laminar boundary layer.
(g) Measurement of velocity and temperature distributions in the boundary layer along a wall of a rectangular-section open-return wind tunnel.
(h) Investigation just started.
(i) Bachelor of Science Thesis by L. Lees to be submitted May 1940.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Civil and Sanitary Eng.

(1050) (a) AN EXPERIMENTAL INVESTIGATION OF THE UPPER AND LOWER CRITICAL VELOCITIES FOR OPEN CHANNELS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) James C. Howland.
(e) Dr. K. C. Reynolds.
(f) To determine experimentally the critical velocity or velocities for laminar and turbulent flow in an open channel of rectangular cross-section.
(g) A tilting glass-walled channel of rectangular cross-section was used, 2 inches wide, 6 inches high and 20 ft long. The rate of discharge was determined by weighing. The flow was always uniform.
(h) Thesis with title of (a) submitted in October 1939.
(i) Experiments indicate a higher critical velocity than that conventionally obtained from pipe flow data. Channels of other cross-sections are to be investigated. This thesis is one of several which constitute a long-range study of flow in open channels. Also, see Projects 1051, 1052, 1053.

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(1051) (a) AN EXPERIMENTAL INVESTIGATION OF THE UPPER AND LOWER CRITICAL VELOCITIES FOR OPEN CHANNELS.
(b) River Hydraulic Lab., M.I.T.
(c) Master's thesis.
(d) Lt. John H. Dudley of Corps of Engineers, U.S.Army.
(e) Dr. K. C. Reynolds.
(f) To determine experimentally the critical velocity or velocities for laminar and turbulent flow in an open channel of rectangular cross-section.
(g) This thesis was a continuation of that by Mr. Howland. See Project 1050.
(h) Thesis with title of (a) submitted in October 1939.
(i) Experiments indicate a higher critical velocity than that obtained from pipe flow data.

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(1052) (a) AN EXPERIMENTAL INVESTIGATION OF THE VARIATION OF THE COEFFICIENT OF FRICTION WITH REYNOLDS' NUMBER FOR OPEN CHANNEL FLOW.
(b) River Hydraulic Lab., M.I.T.
(c) Master's thesis.
(d) Lt. Craig Snyser and Lt. Raymond J. Harvey, of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) A tilting wooden flume of rectangular cross-section was used, 38 ft long, 12 in. wide and 16 1/2 in. high. The flow was measured by a calibrated, rectangular, suppressed weir and was always uniform.
(h) A thesis with title of (a) submitted in October 1939.
(i) A value of "n" of about 0.0034 was found to be constant with Reynolds Numbers greater than 10,000. A decrease in Darcy's "f" was obtained as the Reynolds number increases.

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(1053) (a) AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VARIATION IN REYNOLDS' NUMBER UPON THE COEFFICIENT OF FRICTION IN OPEN CHANNEL FLOW.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. John H. Kerkering and Lt. Arthur M. Jacoby of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a). The thesis was a continuation of the work begun by Mr. Downs. (See Bulletin VII, p. 37, No. 864.)
(g) A wooden flume of rectangular cross-section was used, having a slope of about 0.002 and a test length of 20 ft. Three series of tests were run with widths of 10 1/4 inches, 6 inches, and 3 inches. The walls and bed of the channel were artificially roughened with a uniform-grained sand. The flow was always uniform.
(h) Thesis with title of (a) submitted in October 1939.
(i) Darcy's friction factor "f" was found to decrease with increasing values of the Reynolds number.

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(1054) (a) A MODEL STUDY OF EROSION BELOW THE RIGHT WING WALL OF THE FORT PECK DAM TUNNELS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Kenneth E. Madsen, and Lt. John B. Rippere of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) Erosion of the right bank below Fort Peck, had caused considerable bank cutting when the outlet tunnels were placed in operation. Various means of decreasing the erosion were to be studied.
(g) A 1:145 scale model was built, the model proper being 30 ft by 11 ft. The river bed was movable. Maximum flows corresponding to 78,000 cfs were studied.

(h) Research completed. Thesis with title of (a) submitted in October 1939.
(i) Various combinations of flow through the four tunnels were investigated as well as the use of baffle piers.

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(1055) (a) AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF ANGULARITY OF APPROACH ON THE DISCHARGE COEFFICIENT OF A DAM WITH A ROLLER GATE.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Frederick O. Diercks and Lt. Noel H. Ellis of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) A 1 to 80 scale model was built of one of the three roller gates of Lock and Dam No. 25 on the Mississippi River. The width of an approach channel was kept constant, but the angle it made with the axis of the dam was successively changed to 30°, 45°, 60° and 90°. Flow was measured by a calibrated weir.
(h) Research completed. Thesis with title of (a) submitted in October 1939.
(i) Changes in the angularity of approach above 45° had no measurable effect on the discharge coefficient.

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(1056) (a) AN EXPERIMENTAL INVESTIGATION BY MEANS OF MODELS OF NEGATIVE PRESSURES ON A SPILLWAY SECTION OF A DAM.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Joseph K. H. Leung.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) A dam was designed for a 2-foot head, following the customary practice. Three undistorted models were made having scale ratios of 18, 24, and 36 and provisions made to measure the pressure head on the downstream face.
(h) Research completed. Thesis with title of (a) submitted in October 1939.
(i) The three models did not give the same negative pressures under corresponding heads although their coefficients of discharge showed good agreement.

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(874) (a) EXPERIMENTAL STUDY OF SHORT-CIRCUITING THROUGH MIXING CHAMBERS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Bachelor's thesis.
(d) N. Christensen and S. Morabito.

(e) Prof. T. R. Camp.
(f) To determine suitability of models for studying short-circuiting in mixing chambers by means of dyes.
(g) Two model chambers, one a duplicate of the other but several times larger, were studied to determine if dye patterns can be duplicated and if the Froude model law is satisfactory.
(h) Complete.
(i) Froude model law found to hold for both tank velocity and peripheral velocity of stirring paddles. Dye patterns reproduced faithfully in model.

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(875) (a) RAINFALL INTENSITY - DURATION CURVES FOR BOSTON, MASS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Bachelor's thesis.
(d) H. F. Kennison.
(e) Prof. T. R. Camp.
(f) To check and amend curves prepared by C. W. Sherman (Trans. A.S.C.E. 1931, pg. 951) for a 50-year rainfall record at Chestnut Hill Reservoir on the basis of the 60-year record now available.
(g) Method same as used by Sherman.
(h) Completed.

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(876) (a) HYDRAULICS OF FLOW OF CLEAN WATER THROUGH CLEAN SAND.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Staff research.
(d) Prof. T. R. Camp, D. A. Root, and staff.
(e) Prof. T. R. Camp.
(f) Experimental check of validity of Fair-Hatch theory.
(g) Apparatus consists of sectional glass-tube filter designed for depth of sand of about 2 ft and with 13 piezometer connections throughout depth for head-loss measurements. Distilled water is recirculated downward through sand and is filtered and deaerated on each circuit. When sand is placed, air is removed by agitation and back-washing. Overall porosity is controlled by subsidence of bed after expansion by back wash. Six sands are to be studied: (1) uniform sand with round grains, (2) crushed quartz of uniform size, (3) homogeneous non-uniform sand with round grains, (4) homogeneous non-uniform crushed quartz, (5) non-uniform round sand stratified as to grain size, and (6) non-uniform crushed quartz stratified as to grain size.
(h) Work on uniform sand with round grains and on homogeneous bed of non-uniform crushed quartz has been completed.

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(877) (a) ELECTRIC NETWORK ANALYZERS FOR HYDRAULIC ANALYSIS OF WATER DISTRIBUTION SYSTEMS.
(b) Dept. of Civil and Sanitary Engineering and Dept. of Electrical Engineering, M.I.T.
(c) Master's thesis.

(d) H. T. Strandrud.
(e) Prof. T. R. Camp or Prof. H. L. Hazen.
(f) To study practicability of using lamps as resistance units to represent pipes in an electrical model of a pipe network.
(g) Study comprises investigation of change of resistance in lamp filaments with temperature with view to selecting lamps and corresponding current range with which $V = KI^X$ to correspond with analogous pipe friction formula $h = kQ^X$.
(h) Strandrud's study complete. Other work to follow.

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(1057) (a) EXPERIMENTAL STUDY OF THE DESTRUCTION OF FLOC IN WATER FLOWING THROUGH ORIFICES.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Bachelor's and Master's Theses.
(d) S.M.Clark (S.B.) and A.P.Dennis, Jr. (S.M.)
(e) Prof. T. R. Camp.
(f) To measure the effect of velocity and of size of orifices in settling tank dispersion walls upon the destruction of floc passing through the orifices.
(g) Suspensions of iron-oxide floc were allowed to pass at constant velocity through orifice walls separating two chambers, one of which was used to form the floc; and settling analyses were made on two samples of the suspension, one of which had passed through the wall and the other of which had not.
(h) Work complete.
(i) Results indicate that destructive effect at velocities up to 1.5 fps on type of floc used is confined to larger particles which settle within first 15 minutes. The effect on removal is negligible for settling periods of 1.5 hours or more.

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(1058) (a) EXPERIMENTAL AND THEORETICAL STUDY OF THE MECHANISM OF FILTRATION IN RAPID SAND FILTERS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Doctor's thesis.
(d) P. C. Stein.
(e) Prof. T. R. Camp.
(f) To develop a rational theory of filtration and the rate of clogging of filters to facilitate design and operation.
(g) Experimental and theoretical studies are under way of the manner in which floc deposits within the interstices of the sand bed and the relations thereof with the head loss through the bed. Accompanied by photomicrographs and motion pictures.
(h) Work nearly complete.

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(1059) (a) EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECT OF TURBULENCE UPON THE REMOVAL OF DISCRETE PARTICLES IN SETTLING TANKS.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Doctor's thesis.
(d) W. E. Dobbins.
(e) Prof. T. R. Camp.
(f) To evaluate the effect of turbulence upon the retardation of settling in settling tanks.
(g) The mathematical theory of turbulence is being adapted to the settling problem, and efforts are to be made to check the theory experimentally in settling containers equipped with stirrers to produce vertical mixing.
(h) Apparatus under construction.

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(1060) (a) MODEL STUDIES OF SHORT-CIRCUITING THROUGH FLOCCULATION CHAMBERS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Bachelor's thesis.
(d) J. Echarte.
(e) Prof. T. R. Camp.
(f) To determine the effect of shape on short-circuiting through common types of flocculation chambers.
(g) Two model chambers, one cubical in shape and equipped with a stirring paddle and the other of the round-the-end baffled type, are to be studied by means of dyes.
(h) In progress.

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UNIVERSITY OF MINNESOTA, ST. ANTHONY FALLS HYDRAULIC LABORATORY.

(94) (a) TRANSPORTATION OF SEDIMENT.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (d), (f) and (g) (Details given in earlier bulletins.)

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(99) (a) LAWS OF HYDRAULIC SIMILITUDE.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (d), (f) and (g) (See complete report of this project in earlier bulletins.)

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(190) (a) FLOW CONDITIONS IN OPEN CHANNEL.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(i) Apparatus has been revised to include a larger channel in order to obtain a wider range of Reynolds numbers. Experiments are now being carried on by T. R. Kliegel.
(b), (f) and (g) (These details given in earlier bulletins.)

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(327) (a) EXPERIMENTAL STUDY OF FLUSH VALVES FOR WATER-CLOSETS.
(c) Cooperative research project with Sanitary Division of Minnesota State Board of Health and the Hydraulics Department of the University.
(e) Dr. Lorenz G. Straub.
(b), (d) (f) and (g) (See Complete report of this project in earlier bulletins.)

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(676) (a) FRICTION LOSS IN PLUMBING-SYSTEM PIPE LINES.
(c) Cooperative research project with the Sanitary Division of the Minnesota State Board of Health and the Hydraulics Department of the University of Minnesota.
(e) Dr. Lorenz G. Straub.
(b), (d), (f) and (g) (Details given in earlier bulletins.)

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(677) (a) SEDIMENTATION AT THE CONFLUENCE OF RIVERS.
(b) In cooperation with the Committee on Hydraulic Research of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(d), (f), (g) and (i) (See earlier bulletins for these details.)

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(678) (a) STUDY OF WIND-GENERATED WAVES.
(e) Dr. Lorenz G. Straub.
(b), (d) and (g) (See earlier bulletins for these details.)

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(679) (a) STABILITY OF SAND DAMS.
(b) Project continued in cooperation with Committee on Seepage and Erosion of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(d), (f) and (g) (See earlier bulletins for these details.)

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(983) (a) ST. ANTHONY FALLS NAVIGATION PROJECT.
(b) U. S. Engineer Department.
(d) Staff of U. S. Engineer Department, St. Paul District, Captain J. W. Moreland, District Engineer.
(e) Dr. Lorenz G. Straub.
(h) Experimental studies have been completed.
(c), (g) and (i) (See earlier bulletins for these details.)

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(984) (a) FLOW THROUGH GRANULAR MATERIALS.
(h) A series of experiments has been completed. Report is being prepared.
(b), (c), (d), (e), (g) (See earlier bulletins for these details.)

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(985) (a) HIGH-VELOCITY FLOW IN OPEN CHANNELS.
(b) In cooperation with Committee on Hydraulic Research of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(h) Experimental apparatus is under construction consisting of a channel approximately 50 ft long which can be set at various slopes, up to about 45°. Water enters the channel through a pressure chamber so that eventual velocities up to about 100 fps are contemplated.
(d), (f) (See earlier bulletins for these details.)

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(1061) (a) STUDY OF FLUID TURBULENCE AS RELATED TO SEDIMENT TRANSPORTATION.
(b) Thesis.
(c) An experimental study of the mode of transportation of sedimentary material under idealized conditions.
(d) John S. McNown.
(e) Dr. Lorenz G. Straub.
(g) An experimental channel is arranged with an electrically operated sediment-fed elevator in the upstream end and sediment intercepting traps at the downstream end. The channel is approximately 50 ft long, 12 in. wide, and 18 in. deep. It can be tilted at various slopes. A recirculating system is provided in such a manner that fluids of various viscosities and densities can be used.
(h) Experimental apparatus is under construction.

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(1062) (a) COMPARISON OF FLOW CONDITIONS THROUGH CHANNEL CONTRACTION WORKS WITH MOVABLE AND FIXED BEDS, RESPECTIVELY.
(b) Thesis.
(c) The equilibrium conditions of rigid bed and movable bed channels will be studied at channel contraction works by means of a laboratory set-up.
(d) Enos J. Carlson.
(e) Dr. Lorenz G. Straub.
(g) A channel 12 in. wide and about 18 in. deep and 30 ft long is arranged for insertion of channel contraction works and for transporting sediment by flowing water. Equilibrium conditions will be studied for various conditions of flow and quantity and type of bed load.
(h) Preliminary studies are in progress to determine roughness factors of the channel lining.

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UNIVERSITY OF ILLINOIS.

(301) (a) STUDY OF THE FLOW OF WATER IN A CIRCULAR GLASS PIPE BY THE USE OF MOTION PICTURES.
(c) Laboratory investigation.
(e) Prof. F. B. Seely.
(Continuation of project reported in earlier bulletins of this series.)

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(504) (a) MODEL OF SPILLWAYS OF WATER-SUPPLY RESERVOIRS IN ILLINOIS.
(c) Investigation of capacities, use of measuring devices, and erosion problems.
(e) Prof. F. B. Seely.
(h) Tests of West Frankfort model are completed and the results published in Circular 20 by the Illinois State Water Survey, Urbana, Illinois. Tests of Centralia model nearly completed.
(Continuation of a project reported in earlier bulletins of this series.)

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(626) (a) VELOCITY DISTRIBUTION IN PIPES AT HIGH REYNOLDS NUMBER.
(c) Research.
(e) Prof. F. B. Seely.
(h) Experiments in progress. Thesis completed and on file in University Library. Discussion of a portion published by W. M. Lansford under discussion of Pitot Tubes in Large Pipes, Trans. A.S.M.E. August, 1939.
(Continuation of project reported in earlier bulletins of this series.)

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(739) (a) EFFECT OF RADIUS OF CURVATURE ON THE FLOW OF WATER AROUND PIPE BENDS.
(c) Research.
(e) Prof. F. B. Seely.
(h) Completed. Data being analyzed.
(Continuation of project reported in earlier bulletins of this series.)

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(740) (a) THE HYDRAULICS OF THE FLOW OF SEWAGE SLUDGE.
(b) Engineering Experiment Station.
(c) Scientific research.
(d) H. E. Babbitt, D. H. Caldwell.
(e) Prof. H. E. Babbitt.
(h) Portion dealing with laminar flow completed and to be published soon as bulletin of Eng. Exp. Station.

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(843) (a) A STUDY OF THE HYDRAULIC CHARACTERISTICS OF VALVES.
(c) Student thesis.
(e) Prof. F. B. Seely.
(h) Tests nearly completed.
(Continuation of project reported in earlier bulletins of this series.)

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(1063) (a) AN ANALYTICAL AND EXPERIMENTAL STUDY OF HYDRAULIC RAMS.
(c) Student thesis.
(d) W. G. Dugan; Prof. W. M. Lansford.
(e) Prof. F. B. Seely.

(g) Tests have been made on a 4-inch ram having a thick resilient waste valve and on a 2-inch ram which has a very hard and stiff waste valve.
(h) Tests and analytical work are nearly completed.

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(1064) (a) EFFECTS OF VANES ON THE VELOCITY DISTRIBUTION IN A 24-INCH PIPE.
(b) Student thesis.
(d) C. E. Tarpley; Prof. W. M. Lansford.
(e) Prof. F. B. Seely.
(f) To study the effect on the velocity distribution downstream from a 90° bend in a 24-inch pipe of vanes in or near the bend and to determine the loss in head caused by such vanes.
(h) Tests in progress.

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(1065) (a) A STUDY OF TRANSLATORY WAVES IN AN OPEN CHANNEL..
(b) Student thesis.
(c) W. F. Lytle; Prof. W. M. Lansford.
(e) Prof. F. B. Seely.
(f) Experiments to be made in a channel 5 ft x 5 ft x 140 ft.
(g) Tests in progress.

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(1066) (a) STUDY OF RELIEF VALVES.
(c) Student thesis.
(d) Edward Mauel; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(f) To study the hydraulic operating characteristics of two types of relief valves.
(h) Tests in progress.

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(1067) (a) STUDY OF THE EFFECT OF SUBMERGENCE ON THE VELOCITY DISTRIBUTION IN A PIPE NEAR ITS OUTLET.
(c) Student thesis.
(d) W. H. Chamberlin; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(g) Use of Pitot Tube.
(h) Tests in progress.

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(1068) (a) STUDY OF TURBULENT FLOW THROUGH ANNULAR TUBES.
(c) Student thesis.
(d) J. R. Poyser; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(f) Loss of head and use of a Pitot tube for determining velocity distribution in annular tube having outside diameter of 6 inches.
(h) Tests in progress.

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(1069) (a) HYDRAULICS OF FLOW IN WELLS.
(b) Engineering Experiment Station.
(c) Research.
(d) H. E. Babbitt.
(e) Prof. H. E. Babbitt.
(f) To test existing hypotheses of flow of water into wells.
(g) Observation of laboratory experiments and of wells in the field.
(h) Recently started.

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(1070) (a) RADIAL OUTWARD FLOW OF WATER BETWEEN DISKS.
(b) Research.
(c) Tests of fixed and movable geometrically similar disks in a range of sizes.
(d) Prof. P. E. Mohn.
(e) Prof. F. B. Seely.
(f) To obtain design data and experimental verification of theoretical analysis.
(g) Experimental.
(h) Tests in progress.

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UNIVERSITY OF FLORIDA.

(1071) (a) STUDIES ON THE FLOW OF WATER THROUGH SOILS. STUDIES ON THE DESIGN OF SEDIMENTATION TANKS.
(b) University of Florida.
(c) Laboratory research.
(d) Henry J. Miles - Assistant Professor of Civil Engineering J. F. Shivler, and M. Gomez - Graduate Assistants in Civil Engineering.
(e) Prof. Henry J. Miles.
(f) Purpose as stated in title.
(g) Present investigation limited to review of literature and preliminary laboratory work.
(h) Investigations now under way.

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WORCESTER POLYTECHNIC INSTITUTE.

(907) (a) PITOT TUBES.
(b) Hydraulic Prime Movers Committee, A.S.M.E.
(c) Research.
(d) Professor C. W. Hubbard.
(e) Professor C. M. Allen.
(f) To study the effect of turbulence on pitot tubes and carry forward the work described in the paper "Investigation of Errors of Pitot Tubes" by C. W. Hubbard, published in A.S.M.E. Transactions August, 1939.

(g) A smaller and better turbulence measuring device known as an "angularity indicator" was used to measure the intensity of turbulence in three different 12" pipes. Studies were made with a pitot-static tube in each of the pipes and the coefficient found to vary from .99 to .95. A stable coefficient of 0.89 was obtained by disturbing the flow near the pressure head orifice with a ring.
(h) Not complete, although many results of this later work are given in the closure of the paper published in the A.S.M.E. Transactions for August, 1939.

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(1072) (a) ELECTRICAL POLARIZATION TESTS WITH SALT VELOCITY ELECTRODES.
(b) (c) Alden Hydraulic Laboratory research.
(d) Professor L. J. Hooper.
(e) Professor C. M. Allen.
(f) To determine effects of polarization when using a D.C. supply when working with the salt-velocity method.
(g) Polarization voltages measured at various current densities and water velocities for different electrodes. Rate of growth and decay also determined.
(h) Work completed.
(i) Data on file.

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(1073) (a) LOW-VELOCITY TESTS WITH THE SALT-VELOCITY METHOD.
(b) (c) Alden Hydraulic Laboratory research.
(d) Professor L. J. Hooper.
(e) Professor C. M. Allen.
(f) To study the low-velocity characteristics of the method.
(g) Two sets of tests have been made. In the first series the measurements were made in a horizontal 10" pipe, checking the discharge by a calibrated 8' weir and a calibrated 36" x 16" venturi meter. In the second series of tests, the measurements were made in a vertical 12" pipe which could be reversed.
(h) Tests still in progress.

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(1074) (a) NORTHAMPTON DIKE DROP STRUCTURE.
(b) United States Army Engineers Corps.
(c) Commercial research.
(d) Professor C. W. Hubbard.
(e) Professor C. M. Allen.
(f) To determine by a model test the best form of drop structures for a flood-control project so that during floods the velocity in the diversion channel would be reduced to safe values.

(g) A model, 1/50th full scale, of a portion of the diversion channel and the proposed drop structure and highway bridge was constructed and tested. Four designs were studied. Tests were also made of methods to prevent erosion of the bed just below the structure at the highest expected flood flows.
(h) Completed.

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(1075) (a) TESTS OF 6-INCH MODEL DOW WASTE VALVE.
(b) Stone & Webster Engineering Corporation, Boston, Mass.
(c) Commercial research.
(d) Professor C. W. Hubbard.
(e) Professor C. M. Allen.
(f) To determine the best form of outlet for the full-size 6 ft valve to prevent damage and erosion when discharge occurred under 44 ft head, full scale. Also to determine the hydraulic forces exerted on the valve.
(g) A model, 1/12th full scale, representing the proposed tailrace, waste valve, and penstock was constructed. Tests were run at heads corresponding to 44 ft full scale, and the tailrace and outlet modified until a safe flow condition was assured. The forces on the valve were weighed on small scales by connecting an operating link to a bridle on the scales. The force on the Dow valve was measured from the closed to the wide open position.
(h) Completed.

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(1076) (a) CALIBRATION OF VELOCITY VANE.
(b) Builders Iron Foundry, Providence, R. I.
(c) Commercial research.
(d) Professor C. W. Hubbard, H. W. Leeson.
(e) Professor C. M. Allen.
(f) To design a submerged vane which would have a consistent relation between angle and velocity to indicate direction and rate of flow, large connecting channel in which flow varies from low velocity through zero to flow in opposite direction.
(g) Special flat vane suspended from horizontal axis having magnetic connection to cable operating indicating pointer. Tested on rotating boom. Area and weight of vane varied until desired relation between angle and velocity was obtained.
(h) Completed.

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(1077) (a) CALIBRATION OF 20-INCH VENTURI CONTROLLER.
(b) Builders Iron Foundry, Providence, R. I.
(c) Commercial research.
(d) Professor C. W. Hubbard, H.W. Leeson.
(e) Professor C. M. Allen.

(f) Study of operation of venturi controller to automatically maintain a constant flow with changing head.
(g) The 20" venturi controller was connected to a 20" supply line and tests made at changing values of head to determine the ability of the controller to maintain steady flow. Tests were also made to determine the hydraulic forces acting on the controller gate or vane.
(h) Completed.

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(1078) (a) CALIBRATION OF SPECIAL FLOW NOZZLES.
(b) Builders Iron Foundry, Providence, R. I.
(c) Commercial research.
(d) Professor C. W. Hubbard, H. W. Leeson.
(e) Professor C. M. Allen.
(f) Test of three sizes of special nozzles known as Kennison Flow Nozzles to measure the flow of water from the end of a pipe. These nozzles are really a special form of weir.
(g) Nozzles were connected by proper size of pipe to a head box. The flow into the head box was measured by venturi meters calibrated by weighing tank. Head on invert flow nozzle was measured by hook gage. Flow nozzles calibrated throughout whole useful range.
(h) Completed.

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COLORADO STATE COLLEGE.

(1079) (a) METER FOR DITCH FLOWS.
(b) Soil Conservation Service, Division of Irrigation, U.S.D.A., and the Colorado Experiment Station, cooperating.
(c) To perfect a new type of water-measuring device with a recording and indicating mechanism attached.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, senior irrigation engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To develop a useful and practical meter of relatively cheap design to meet the need of distributing irrigation water supplies to farmers.
(g) To develop the new type of measuring device and recording instrument in the laboratory; also to test out under practical field conditions.
(h) No definite work has yet been developed in the laboratory or field relative to this project.
(i) It is expected that some preliminary work may be possible this fiscal year.

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(1080) (a) SIPHON SAND TRAP.
(b) Soil Conservation Service, Division of Irrigation, U.S.D.A., in cooperation with the Colorado Agricultural Experiment Station.
(c) To set up laboratory apparatus as a model to investigate the possibilities of this type of sand trap.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, senior irrigation engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To develop a new type of sand-trap device capable of removing bed load from a channel under limited sluicing facilities and conditions.
(g) To arrange model apparatus in the laboratory whereby the bedload in a channel can be removed and deposited at a higher elevation, by advantage of differences in water stages in channel and outside. Should laboratory studies warrant, a full scaled device is to be tried out under practical conditions in the Arkansas Valley in Colorado.
(h) Some of the apparatus necessary in conducting laboratory studies of this type of sand trap has now been prepared.
(i) Preliminary observations at the Bellvue laboratory are planned this fiscal year.

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(1081) (a) COLLECTION OF SNOW SURVEY DATA.
(b) Soil Conservation Service, Division of Irrigation, U. S. D. A., in cooperation with the Colorado Agricultural Experiment Station.
(c) Collection of field data in cooperation with several federal and state cooperators.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, senior irrigation engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) The collection of snow cover data as the basis of forecasting irrigation water supplies.
(g) Cooperating agencies make monthly snow surveys at definite locations in the high mountain country of Colorado, Wyoming, New Mexico and Utah. These observations are usually made the first of February, March, April and May each year.
(h) Such surveys have continued each winter since February 1936, and the records now accumulated form the working basis of establishing the relationship between snow cover and stream flow.
(i) This is a continuing project.

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(1082) (a) METERS FOR PIPE FLOWS.
(b) Soil Conservation Service, Division of Irrigation, U.S.D.A., in cooperation with Colorado Agricultural Experiment Station.
(c) To make laboratory tests on apparatus preliminary to design, and later to operate under practical field conditions.
(d) R. L. Parshall and assistants.

(e) R. L. Parshall, senior irrigation engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To investigate the possibilities of developing useful and practical instruments for indicating and totalizing the flow or discharge in pipe lines as a means of more efficient operation of pumping plants, and other purposes.
(g) Test out present ideas as applicable to the problem by preliminary apparatus set up in the laboratory. The present scope of the problem involves two different plans of approach.
(h) No work has yet been accomplished on this project.
(i) It is likely that some of the preliminary investigations may be possible before the end of this fiscal year.

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(1083) (a) RELATION OF SNOW COVER TO RUN-OFF.
(b) Colorado Experiment Station and Soil Conservation Service, Division of Irrigation, cooperatively.
(c) Compilation and analysis of snow cover and streamflow data.
(d) W. E. Code and assistants.
(e) W. E. Code, Colorado Experiment Station, Fort Collins.
(f) Preparation of charts and diagrams for the purpose of forecasting stream flow from snow-pack observations for agricultural, industrial and municipal interests.
(g) From the data gathered from the snow surveys and the records of stream flow as furnished by the U. S. Geological Survey and various State Engineers, diagrams are being made from the plottings of these two quantities. This is the simplest form of study, and other means may be employed of a more detailed character later when records covering a greater period of time have accumulated. From such charts, experience in other states has shown that stream flow from the snow cover can be predicted with reasonable accuracy.
(h) Not much progress has been made because of lack of data. It has been possible to compare but three years of snow-pack observations with stream flow in the cases of the longest records.
(i) More precipitation stations are needed at high altitudes in order to determine the effects of late snows and early rains. More stream-gaging stations are needed in some localities for rational subdivision of areas controlled by any one snow course.

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(1084) (a) USE OF GROUND WATER IN THE SOUTH PLATTE BASIN IN COLORADO FOR 1940.
(b) Colorado Experiment Station and Soil Conservation Service, cooperatively.
(c) Evaluation of output of irrigation pumping plants.
(d) W. E. Code.
(e) W. E. Code.
(f) Determination of the extent of use of ground water for irrigation, its growth and the possible effect upon return flow to the South Platte.

(g) The discharge of each pumping plant will be determined if possible by using pump capacity and test data available in a large number of cases and by controlled estimates in others. The total volume will be arrived at through the amount of electricity or fuel oil used or pumping records. About 1100 plants will be investigated. The measurement of return flow or seepage has received some attention by the Colorado Experiment Station and the State Engineer since 1891. A study of these measurements in connection with the pumping and the total water supply of the basin will be made.
(h) Project is just getting started and will be finished early in 1941.
(i) Only a small degree of accuracy in the data is anticipated.

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(1085) (a) GROUND-WATER FLUCTUATION.
(b) Colorado Experiment Station and Soil Conservation Service, cooperatively.
(c) Stated in title.
(d) W. E. Code.
(e) W. E. Code.
(f) To determine in certain areas the effects of pumping and irrigation on the height of the water table.
(g) Twice annually, before and after the irrigation season, steel-tape measurements are made to the water surface in about 110 observation wells. The wells are located only in pumping districts of the South Platte and Arkansas Basins.
(h) This program was started in 1928 and 1929 and has been carried on continuously.
(i) Records show that definite conclusions may be drawn in a number of pumping areas.

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(1086) (a) INVESTIGATION OF PHOTOGRAPHIC METHOD FOR MAKING SNOW SURVEYS.
(b) The Colorado Experiment Station and the Soil Conservation Service, Division of Irrigation, cooperating.
(c) Photographs are made of a section of the watershed at high elevations and from them the percentage of area covered by snow is determined.
(d) Maxwell Marshall, N. A. Christensen.
(e) Maxwell Marshall.
(f) To devise a photographic method of forecasting runoff from snow cover and if possible to eliminate, where possible, much time and effort in making snow surveys by the present method.
(g) The method consists of taking monthly photographs during the snow season of a definite section of the watershed at high elevation, from an easily accessible location, and determining the percentage of area covered by snow. A comparison of area covered to runoff is hoped to be the basis of stream forecast. At present only one location is being investigated.
(h) Two years' photographs of a definite section of the Poudre River watershed are on file, but no analytical work has as yet been completed.

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(1087) (a) METEOROLOGICAL OBSERVATIONS FOR CLIMATOLOGICAL RECORD.
(b) The Colorado Experiment Station.
(c) Observations are made of the various meteorological elements.
(d) Maxwell Parshall.
(e) Maxwell Parshall.
(f) To determine the climate of Fort Collins, Colorado, and to furnish such meteorological data as may be necessary for research programs in the various departments of the Colorado Experiment Station.
(g) Observations are made twice daily at 7 a.m. and 7 p.m. and consist of: barometric pressure, maximum and minimum temperatures, dewpoint and relative humidity, terrestrial radiation thermometer temperature, soil temperature at 3, 6, 12, 24, 36, and 72 inches depth, and wind movement for 24 hours. During the ice-free season - April 1 to about November 15 - observations are made at the same times of day on evaporation from a free water surface. These observations consist of the loss of water in inches, temperature of the water, maximum and minimum temperatures of the water during the 24-hour period, and wind movement over the water surface. Rainfall and snow depths are measured when they occur. General remarks of meteolorogical phenomena are recorded. A graphic record is made of wind direction, wind velocity, sunshine, barometric pressure, and temperature. During the ice-free season a graphic record of rainfall is made.
(h) The meteorological record is complete as indicated from 1887 to date, while the evaporation record was not initiated until May 1890, but is complete from that data to the present.
(i) A bulletin analyzing and summarizing fifty years of meteorological data has recently been prepared.

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(1088) (a) COMPARISON BETWEEN OBSERVED AND CALCULATED EVAPORATION, USING FORMULA DEVELOPED BY CARL H. ROHWER.
(b) The Colorado Experiment Station and the Soil Conservation Service, Division of Irrigation, cooperating.
(c) The preparation of tables of observed and calculated rates of evaporation at the Colorado Experiment Station.
(d) Maxwell Parshall, Edward Trainor, Roger Smith.
(e) Maxwell Parshall.
(f) To compare the observed and calculated evaporation rates as observed at the Colorado Experiment Station.
(g) The method consists of tabulating the original evaporation observations and checking the monthly total and averages. The rate of evaporation is calculated for 12-hour intervals where sufficient data are available and the observed evaporation is tabulated alone where insufficient data are available for calculating the rate of evaporation. The observed evaporation data are available during the ice-free season from May 1890 to date.

(h) The observed data is complete and is completely tabulated. About half of the data is checked and about half the values of rate of evaporation have been calculated.
(i) N.Y.A. student assistance is being used for a majority of the work.

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(1089) (a) DESIGN OF HYDRAULIC SAND SEPARATOR.
(b) Colorado Experiment Station in cooperation with the Soil Conservation Service, Division of Irrigation.
(c) This is to be a laboratory investigation the purpose of which is to design a hydraulic sand separator which may be used (a) to synthesize sands for hydraulic model studies and (b) to analyze sands moved in irrigation streams.
(d) Dr. Dwight Gunder and assistants.
(e) Dr. Dwight Gunder, Professor of Mathematics, Colorado State College.
(f) This proposed apparatus, when perfected, will be used in connection with a larger investigation on the similarity principles governing the motion of sand in fluid flows.
(g) A design will be made and its performance checked in the hydraulic laboratory. The scope is to be limited to the perfection of a satisfactory separator which may be used for the purpose already mentioned.
(h) Preliminary plans have been prepared, and certain preliminary trials made.
(i) This project is to be resumed at the beginning of the second semester of the present school year.

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(1090) (a) DESIGN OF FALL VELOCITY APPARATUS.
(b) Colorado Experiment Station in cooperation with the Soil Conservation Service, Division of Irrigation.
(c) A laboratory investigation in order to perfect an apparatus which may be used to measure the fall velocity of particles in water.
(d) Dr. Dwight Gunder and assistants.
(e) Dr. Dwight Gunder, professor of mathematics, Colorado State College.
(f) This apparatus is a part of the larger investigation, the purpose of which is to discover the similarity principles which will make possible quantitative hydraulic model studies in which sands are being moved by the flow.
(g) This project will be conducted in the laboratory and is limited to the development of a satisfactory apparatus for the measurement of fall velocity of particles in water.
(h) Preliminary plans have been drawn up.
(i) Work on this project is to be resumed at the beginning of the second semester of the present school year.

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S. MORGAN SMITH COMPANY.

(1091) (a) FRANCIS TURBINE EFFICIENCY AND POWER TESTS - ALTERATIONS MADE ON MODEL ELBOW DRAFT TUBE.
(b) Parker Dam Power Plant. Bureau of Reclamation, Arizona-California.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett, and testing crew for the S. Morgan Smith Company.
(e) Engineering Department - George A. Jessop, Chief Engineer.
(f) To determine the capacity and efficiency of a Francis type runner with modified elbow draft tube design. To select the most efficient design by making alterations to piers and floor of elbow tube.
(g) Investigation was carried out in an open flume setting. All tests were conducted over a large range of speed and sufficient number of gate openings so that curves can be drawn to determine the exact opening to produce the maximum efficiency. Various tests were conducted by making changes to the piers and by changing the slope of the floor in the elbow draft tube.
(h) Tests are completed.

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(1092) (a) KAPLAN TURBINE EFFICIENCY AND HORSE-POWER TESTS - PIERS IN MODEL SCROLL CASE ALTERED.
(b) S. Morgan Smith Company.
(c) Research.
(d) R. Sahle, H. B. Bennett, and testing crew for the S. Morgan Smith Company.
(e) Engineering Department - George A. Jessop, Chief Engineer.
(f) To determine the effect of modification of pier design on the horsepower and efficiency of a standard-design scroll case using a Kaplan turbine.
(g) Tests were conducted with a Kaplan runner in a scroll case of standard design, including the shape and location of two intake piers. The piers were modified as to shape and distance between the center line of unit and downstream nose and comparative results secured. It was found the piers can be extended downstream with satisfactory horse-power and efficiency.
(h) These tests were conducted as part of the investigation being made in connection with the possible installation of additional units at a large hydro-electric project.

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(1093) (a) KAPLAN TURBINE EFFICIENCY AND HORSE-POWER TESTS - MODEL TESTED WITH TWO DISTINCT DESIGNS OF ELBOW DRAFT TUBES.
(b) U. S. Engineer Office, Tennessee Valley Authority, Knoxville, Tenn.
(c) Research.

(d) R. Sahle, H. B. Bennett, and testing crew for the S. Morgan Smith Company.
(e) Engineering Department - George A. Jessop, Chief Engineer.
(f) To determine the horse-power and efficiency of a full-size Kaplan turbine using an elbow draft tube of an altered design. To obtain enough data to compare results over the entire range of head from 40 to 60 ft.
(g) Tests were conducted on an elbow draft tube of standard design and on one of altered design, using the same Kaplan turbine for both tests. The blades were adjustable and were set at five positions. At each position the runs covered a large range of speed and sufficient number of gate openings to determine the comparative results over the entire range of head.
(h) These tests were conducted as preliminary draft tube tests for a Tennessee Valley Authority project.

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(1094) (a) CHECKING THE DIFFERENTIAL OR VENTURI HEAD WITH A THROTTLING ROTOVALVE LOCATED IN A VENTURI THROAT.
(b) Valve Division, S. Morgan Smith Company.
(c) Research.
(d) G. D. Johnson and regular laboratory personnel.
(e) Valve Division; E. C. Brisbane, Chief Engineer.
(f) To determine locations for piezometer connections to the body of a Rotovalve installed in a Venturi throat which will not be affected by the angular position of the Rotovalve plug.
(g) The Venturi section was formed by installing a standard Rotovalve in a pipe line of larger diameter, using standard reducing and increasing sections. The pipe line was connected to a head tank supplied with water by a centrifugal pump. Piezometer connections were placed around the pipe line on the upstream side of the Rorovalve as well as at various locations on the upstream end of the Rotovalve body. The quantity of water flowing through the Rotovalve was measured with the laboratory weir. With the Rotovalve plug set at various angles from wide open to nearly closed, the rate of flow through the line was varied and recorded together with the differential or Venturi head. Readings of the various piezometer connections on the Rotovalve body were taken and recorded.
(h) Tests are completed.

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PRINCETON UNIVERSITY.

(1095) (a) INVESTIGATION OF THE CORRELATION OF METER COEFFICIENTS FOR ROUNDED ENTRANCE NOZZLES AND VENTURI METERS.
(b)(c) Experimental research. (Thesis for Eng'g degree).
(d) John K. Rudd, Asst. Dept. of Mechanical Engineering.
(e) Prof. Lewis F. Moody.
(f) to (h) A homologous set of three rounded-entrance nozzles were tested as to discharge coefficients, using both throat taps and "tail tank taps" or the pressure in the discharge tank.

Tests were made for free and submerged discharge. The nozzles were used alone and with conical diffusers attached, converting them into rounded-entrance Venturi meters. Curves plotted against Reynolds numbers show comparisons of the nozzles alone and as parts of Venturi meters. Discharges were measured by a calibrated Venturi meter. It was found that downstream conditions, such as the presence or absence of a diffuser, have very small effect on the coefficients, and that the coefficients for free and submerged discharge are the same. Effects of size of nozzle, etc., are discussed in the paper. Paper completed, June 1939.

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(1096) (a) INVESTIGATION OF DIFFUSERS IN RECTANGULAR CONDUITS.
(b)(c) Experimental research. (Thesis for engineering degree.)
(d) Charles E. Swing. (Graduate student.)
(e) Prof. Lewis F. Moody.
(f) to (h) A sloping roof was fitted in a 12" wide x 12" high glass flume about 8 ft long. The sloping roof joined a horizontal roof at its downstream end. Various angles of slope were used. The flow entered from a tank through a rounded entrance and a short horizontal passage. The floor of the flume is horizontal throughout.

Thus a diffuser passage was provided with two sides parallel, and two diverging, with the flow entering in the direction of one side. The conditions resemble those in the horizontal discharge section of an elbow draft tube for turbines. The efficiencies of conversion of velocity head into static head were found for various angles of divergence, etc. One of the conclusions was that "for diffusers having two sides diverging with respect to the initial flow line, the angle between opposite divergent faces at which maximum efficiency is obtained is approximately double the angle of maximum efficiency for diffusers having only one side diverging---". Other details are given in paper; completed June, 1939.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC STRUCTURES LABORATORY.

(656) (a) INVESTIGATION OF HIGH VELOCITY FLOW AROUND BENDS IN OPEN CHANNELS.
(b) Los Angeles County Flood Control District.
(c) Cooperative study with Los Angeles County Flood Control District
(d) Prof. Robert T. Knapp and Dr. Arthur T. Ippen.
(e) Prof. Robert T. Knapp.
(f) On the basis of the results of Project 357 to investigate designs and methods of changing the direction of flow in open channels without excessive superelevation in the curve or in the downstream tangent under condition of shooting flow.
(g) Extensive series of designs were tested and alternate methods of construction were developed to reduce the disturbance in and below the curves.

(h) Project completed and results submitted to the Los Angeles County Flood Control District. An abstract of the results and suggestions was presented as a paper at the Fifth International Congress for Applied Mechanics, which met in Cambridge, Massachusetts, September, 1938, and will appear in the Proceedings of the Congress.
(i) Report of this work reproduced in two volumes by U. S. Engineer Office at Los Angeles under date of September, 1939 and privately circulated to all District Engineer Offices.

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(832) (a) THE REDUCTION OF THE DISTURBANCES PRODUCED BY CHANGES OF DIRECTION OF SHOOTING FLOW IN OPEN CHANNELS.
(b) Laboratory project.
(c) Research for thesis for Ph. D. degree.
(d) W. O. Wagner.
(e) Prof. Robert T. Knapp, W. O. Wagner.
(f) A continuation of Projects 357 and 636 to study additional methods of control for high velocity channels.
(g) The equipment used in Project 656 and a short variable slope flume of the same cross section are being used for the experiments. The lines of investigation are being drawn on the basis of the analysis of the mechanism of flow developed in the previous projects.

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(1097) (a) INVESTIGATIONS OF FLOW IN CURVED NON-RECTANGULAR CHANNELS.
(b) Laboratory project.
(c) Research for thesis for M. S. degree.
(d) O'Dean Anderson, Justus A. Olsson.
(e) Dr. R. T. Knapp.
(f) Methods of minimizing disturbances in non-rectangular flumes due to high-velocity flow in curves.
(g) It is proposed to use the principles developed in the study of high-velocity flow in rectangular channels by Arthur T. Ippen and Robert T. Knapp in 1938. The method to be followed in this investigation is to use a different channel cross-section around the curve.
(h) Apparatus constructed and ready for experimental work.

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(1098) (a) PULSATING FLOW CHARACTERISTICS OF PIPE LINES.
(b) Shell Oil Research Fellowship.
(c) Laboratory investigation.
(d) P. S. Devirian, Jr.
(e) R. L. Daugherty, R. T. Knapp, P. S. Devirian.
(f) To determine frictional and operating characteristics of pipe lines subject to pulsating flow.
(g) Controlled pulsating flow produced by mechanically driven valve in pipe line of approximately 3400 diameters length. Flow characteristics to be determined for pulsation frequencies at or near resonance with natural surge frequency of line.
(h) Apparatus nearing completion.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC MACHINERY LABORATORY.

(818) (a) STUDY OF PRACTICAL LIMITS OF SPECIFIC SPEED FOR GRAND COULEE PUMPING PLANT.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán and Mr. D. P. Barnes.
(f) See (a).
(g) Tests covering a wide specific speed range are made on large scale model pumps. Cavitation performance and head-capacity characteristics determined from precise dynamometer tests are compared for several typical designs at each specific speed. For a description of the special laboratory equipment used for this work, see A.S.M.E. Transactions for November, 1936, Hyd-58-5 by R. T. Knapp, "The Hydraulic Machinery Laboratory at the California Institute of Technology".
(h) Investigation partially completed. Information not available for distribution.

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(819) (a) AN INVESTIGATION OF THE CHARACTERISTICS OF SEVERAL TYPES OF PUMP CASINGS AND A COMPARISON OF THEIR ADVANTAGES.
(b) U. S. Bureau of Reclamation.
(c) Cooperative research program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, R. L. Daugherty, and Mr. D. P. Barnes.
(f) A systematic and accurate comparison is desired for the several types of pump casings proposed for the Grand Coulee installation.
(g) Precise dynamometer tests of pumps using a variety of casing types furnish data necessary for comparison of such items as cavitation performance, head-capacity-power characteristics, and unbalanced radial forces.
(h) Investigation is to be continued with special emphasis placed upon various multivane volute pumps and fixed-vane diffuser type pumps.

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(820) (a) STUDY OF ENERGY LOSSES IN DIFFUSERS INSTALLED AT THE DISCHARGE FLANGE OF CENTRIFUGAL PUMPS
(b) Hydraulic Machinery Laboratory Research Program.
(c) General Laboratory Investigation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. Von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) An accurate knowledge of losses in such diffusers is necessary for the proper evaluation of pump and line loss characteristics.
(g) Precision tests of pumps with diffusors of various angles of divergence provide data used in this analysis. Accurate comparisons are possible from measured overall losses and measured pressure distributions along the diffusors.

(h) The initial investigation of energy losses in diffusers has given interesting but incomplete information. It is planned to conduct further experiments before formal conclusions are presented.

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(821) (a) STUDY OF PRE-ROTATION AND REVERSE FLOW AT THE EYE OF A CENTRIFUGAL PUMP.
(b) U. S. Bureau of Reclamation Research Program.
(c) Research for thesis for Ph. D. degree.
(d) James W. Daily.
(e) Professors R. T. Knapp, R. L. Daugherty and Th. von Kármán.
(f) Experimental verification of the flow characteristics within a centrifugal pump, especially in the region near the impeller eye.
(g) Special equipment has been constructed for use with the cylindrical direction-finding type pitot tube. Velocity and static pressures as well as direction of flow are obtained with the aid of zero volume differential gages. The existing flow picture is correlated with the performance characteristics of the pump.
(h) Measurements have shown conclusively that pre-rotation existing in the pipe leading to the inlet of a centrifugal pump is accompanied by an actual mass transfer of water out of the impeller at the periphery of the eye. This mass of water flows upstream along the periphery of the pipe with a rotational component dependent upon the speed of the pump and the mean rate of flow. The increase in pressure at the pipe wall due to the rotation often results in measured pressure gradients increasing in the direction of the mean flow. At low capacities the back flow can amount to many times the magnitude of the mean flow through the pump.

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(822) (a) STUDY OF EFFECT OF AIR CONTENT ON CAVITATION PERFORMANCE OF CENTRIFUGAL PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative research program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán, and Mr. D. P. Barnes.
(f) To determine effect of dissolved air on cavitation performance.
(g) Investigation of the validity of bubble point as cavitation parameter. An apparatus is being constructed for the purpose of accurately determining the bubble point pressure as a function of temperature. Bubble point measurements will be correlated with the cavitation limits determined from precise dynamometer tests.
(h) Initial studies using the special bubble-point apparatus have been made upon saturated and air-free water samples. Further measurements are to be made on water samples taken from the pumping circuit during tests.

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Note - Page 64 omitted - Page 65 follows.

(823) (a) STUDY OF EFFECTS OF ANGULAR VELOCITY COMPONENTS ON CYLINDRICAL DIRECTION-FINDING PITOT TUBE.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) James W. Daily, C. A. Gongwer.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán, and Mr. D. P. Barnes.
(f) The cylindrical direction-finding pitot tube is being used to measure high velocity flows where the direction of the flow may be at any angle with respect to the tube position. An accurate knowledge of its characteristics under such conditions is desirable.
(g) Special apparatus has been constructed to permit the cylindrical tube to be inserted in high-velocity streams at known angles of yaw. Characteristics will be determined in the form of measured pressure distributions around the cylinder.
(h) Initial investigations have demonstrated the possibilities of obtaining accurate flow measurements with the cylindrical type pitot tube. A short set of measurements was taken for angles of yaw to 70° with results showing a nearly linear relationship. The mean-flow measuring device used in conjunction with this apparatus has been redesigned, and experiments are to continue.

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(824) (a) STUDY OF THE EFFECTS OF THE VELOCITY AND PRESSURE DISTRIBUTION AT THE IMPELLER EYE UPON THE CAVITATION PERFORMANCE OF CENTRIFUGAL PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty, and Mr. D. P. Barnes.
(f) (See (a)).
(g) Velocity and pressure distributions are determined in a normal plane immediately upstream from the impeller eye for several types of inlets. Also a device has been constructed for controlling the velocity distribution at the inlet flange. With this device a wide range of symmetrical velocity distribution can be obtained. Cylindrical direction- finding pitot tubes are used for traversing the plane. Both the magnitude and the direction of the velocities are determined. These velocity and pressure distributions are then correlated with the cavitation limits determined from precise dynamometer tests.

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(825) (a) INVESTIGATION OF THE FLOW CHARACTERISTICS OF PUMP INLET PIECES USING MODELS IN AIR STREAM.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) James W. Daily, George Morikawa, Brooks T. Morris.
(e) Professors Th. von Kármán, R.T. Knapp, and R. L. Daugherty, and Mr. D. P. Barnes.
(f) The effect of the inlet condition on centrifugal characteristics is associated with the resulting velocity distribution at the impeller eye. The effect of variations in the inlet on the velocity profiles can be readily determined with air model studies.

(g) A wind tunnel for use with pyralin models is under construction. Power is available for developing Reynold's numbers up to approximately one million based on 2-ft throat diameter. Pitot traverses at different cross sections of the inlet will furnish information required for the analysis.
(h) Active investigations were temporarily suspended on this project but have now been resumed.

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(826) (a) DETERMINATION OF UNBALANCED RADIAL FORCES IN THE VOLUTE OF A CENTRIFUGAL PUMP AND THEIR CORRELATION FOR DIFFERENT TYPES AND DESIGNS OF PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty, and Mr. D. P. Barnes.
(f) Shaft deflections and resultant wear between rotating and stationary parts of centrifugal pumps, as well as accurate interpretation of observed peculiarities in pump performance requires a knowledge of unbalanced radial forces in the volute.
(g) Static pressure distributions obtained from piezometer stations located in the volute walls are supplemented by actual deflection measurements for the wide variety of pumps tested in the laboratory.
(h) Measurements have shown that summation of the radial forces acting upon the impeller is equal to zero at one definite capacity. As the rate of discharge is increased or decreased, an unbalance occurs, giving resultant forces of high magnitude. In general these resultant forces do not fall in the same plane. For well-designed pumps the point with no resultant radial force occurs near the operating range.

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(827) (a) DETERMINATION OF BOTH AVERAGE AND INSTANTANEOUS VELOCITY AND PRESSURE DISTRIBUTIONS IN THE VOLUTE OF A CENTRIFUGAL PUMP.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General laboratory investigation.
(d) Hydraulic Machinery Laboratory staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) Experimental verification of the flow characteristics in the pump volute.
(g) By means of a precision dual-slide valve and special differential gage, instantaneous readings of velocity and pressure are being obtained. Their correlation with the average distributions furnish an experimental basis for an analytical examination of centrifugal pump performance.
(h) Measurements have been completed for two different types of volute pumps. Correlation of the results with existing theoretical flow pictures is being made.

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(828) (a) STUDY OF CAVITATION FLOW IN CENTRIFUGAL PUMP IMPELLERS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) C. A. Gongwer and laboratory staff.
(e) Professors Th. von Karman, R. T. Knapp, and R. L. Daugherty.
(f) To correlate quantitatively and qualitatively the influence of operating conditions and design elements upon the occurrence of cavitation.
(g) Determinations of cavitation limits of a large number of impellers of various designs, under different operating conditions and in different casings, have led to the conclusion that the influences of inlet shroud curvature and vane tip design can be isolated in relation to the flow and speed by means of dimensionless parameters more nearly universal than the "sigma" or "suction specific speed" in current use.
(h) Final drafts of a bulletin summarizing this material are in preparation.

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(829) (a) COMPILATION OF COMPLETE CHARACTERISTIC PERFORMANCE OF CENTRIFUGAL PUMPS OF VARIOUS TYPES OF SPECIFIC SPEEDS.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General laboratory research.
(d) R. T. Knapp, and James W. Daily.
(e) Professors Th. von Karman, R. T. Knapp and R. L. Daugherty.
(f) and (g) Complete characteristic diagrams of centrifugal pumps are necessary for use in analyzing the transient behavior of pumps in specific installations. A series of diagrams for all types of centrifugal pumps is being compiled for comparison purposes.
(h) Preliminary publication made in A.S.M.E. Transactions, November, 1937, Hydr.-59-11 by R. T. Knapp, "Complete Characteristics of Centrifugal Pumps and their use in the Prediction of Transient Behavior". No additional publications are yet available.

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(830) (a) AN EVALUATION OF STEPS NECESSARY IN ANALYTICAL REDUCTION OF DATA OBTAINED FROM PRECISION TESTS OF HYDRAULIC MACHINES.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General laboratory research.
(d) James W. Daily, Joseph Leffler.
(e) Professors Th. von Karman, R.T. Knapp and R. L. Daugherty.
(f) Refinements in testing equipment and technique require thorough attention be given to methods of evaluation, including determination of physical constants, if all the advantages of the precision tests are to be obtained. Information is being collected and analytical methods developed for use in the Hydraulic Machinery Laboratory which are thought to be of general interest and importance. A summary of data and description of methods is being prepared for distribution.
.....(h) Active investigations temporarily suspended have been resumed.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Cooperative Laboratory, Soil Conservation Service.

(656) (a) THE USE OF PROBABILITY GRAPHS IN THE INTERPRETATION OF MECHANICAL ANALYSES OF SEDIMENTS.
(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto.
(e) Prof. Robt. T. Knapp, Vito A. Vanoni, Geo. H. Otto.
(f) To set forth efficient graphical methods and systematical procedure for critical study of a series of related mechanical analyses of sediments.
(g) A modified logarithmic probability graph was developed and tested with actual field sediments.
(h) Research completed. Publication, "A Modified Logarithmic Probability Graph for the Interpretation of Mechanical Analyses of Sediments" by George H. Otto, Journal of Sedimentary Petrology, Vol. 9, No. 3, August, 1939.

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(659) (a) MECHANICS OF SUSPENDED LOAD TRANSPORTATION.
(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Prof. Robert T. Knapp, Vito A. Vanoni.
(e) Prof. Robert T. Knapp, Vito A. Vanoni.
(f) To investigate the internal mechanics of transportation of suspended load by flowing water; the effects of the material in suspension upon the velocity distribution of the flow; the distribution of sediment in open channel flow.
(g) The experiments are carried on in a flume 33 inches wide by 60 feet long arranged so the slope can be adjusted to any value up to 1:60. A pump connected to the closed-circuit system of the flume is capable of circulating mixtures of sediment and water at continuously varying rates up to 5 cubic feet per second. Velocity and sediment distribution are obtained from direct measurements made at different elevations in the flow. Velocities are measured with a Prandtl Pitot tube, and sediment concentrations are determined from samples siphoned from the flow at rates corresponding to the velocity of the water at the sampling point.
(h) Techniques and instruments have been developed for sampling the suspended load and conveniently determining the concentrations. Complete data have been obtained for one sediment, one slope, and one bottom roughness for various discharges and total sediment load. The research is being continued.

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(660) (a) DEVELOPMENT OF A HOT-WIRE VELOCITY METER FOR USE IN WATER.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Vito A. Vanoni, E. B. Simmons.
(e) Professor Robert T. Knapp, Vito A. Vanoni.

(f) To develop an instrument suitable for use in determining velocity distribution in flows carrying sediments.
(g) Calibration of hot-wire instrument with alternating and direct current circuits in a 3/4-inch orifice.
(h) Work being continued on part-time basis. No reports to date.

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(661) (a) THE USE OF HYDRAULIC MODELS IN THE DESIGN OF SUSPENDED-LOAD SAMPLERS.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with the Soil Conservation Service.
(d) J. Pat O'Neill.
(e) Professor Robert T. Knapp, Vito A. Vanoni.
(f) The development of a multiple-unit suspended-load sampler and of single-unit line-suspended samplers that cause little disturbance to the flow and, therefore, are satisfactory in suspensions of particles having appreciable fall velocities.
(h) Research completed. A paper by J. Pat O'Neill entitled, "The Use of Hydraulic Models in The Design of Suspended Load Samplers" was presented before the American Geophysical Union, Palo Alto, January, 1940, and will be published in the Proceedings of the society. A more comprehensive report, including working drawings and specifications, is being prepared for publication. See abstract in this Bulletin.

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(662) (a) THE DEVELOPMENT OF A METHOD FOR MEASURING RATE OF FLOW IN STEEP CHANNELS CARRYING SUSPENDED LOAD.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) Hunter Rouse.
(e) Vito A. Vanoni, Project Manager, Robert T. Knapp, Hunter Rouse.
(f) Measurement of flow in the rapid state, without appreciable deceleration and accompanying deposition of sediment.
(g) and (h) See Report in Bulletin VII, page 7.
Investigation completed and report prepared but not published.

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(810) (a) THE STUDY OF SEDIMENT-LADEN FLOWS (DENSITY CURRENTS) IN RESERVOIRS.
(b) Sedimentation Studies Division, Soil Conservation Service.
(c) Cooperative research program with Soil Conservation Service.
(d) Professor Robert T. Knapp, Hugh Stevens Bell.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) To investigate density currents resulting from suspensions of fine sediments in reservoirs, and attempt to establish principles governing their behavior.
(g) Experiments conducted in glass-walled tank 3-inches wide by 10-inches deep by 5-feet long, using a suspension of clay in water to represent the sediment-laden flow.

(h) A systematic set of experiments has been made to study the effect of slope, relative density of the fluids, and the viscosities of the fluids on the behavior of the flows and upon their tendency to mix. Observations made with motion and still pictures. A study of the effect of underflows upon the velocity distribution within the reservoir has been initiated. Vertical velocity distributions within the density flows have been made, but the study is not complete. A few experiments have been made to investigate the possibility of density currents resulting from suspensions caused by wave action either on beach or bottom deposits in shallow water. Experiments are being continued.

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(812) (a) HYDRAULIC DESIGN OF EROSION-CONTROL STRUCTURES BY MEANS OF MODEL TESTS.
(b) Hydrologic Division and Operations Division, Southwest Region, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Brooks T. Morris, Vito A. Vanoni.
(e) Prof ssor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) To improve existing designs and develop new designs for erosion-control structures used in field operations.
(g) Proposed designs of specific structures are tested and modified through hydraulic model studies in the laboratory. Typical structures intended to cover a wide range of field conditions are also tested with a view to improving design standards. In this work close and active cooperation is maintained between the laboratory and field.
(h) A series of tests to develop standard designs for dams of the contracted overfall type has been partially completed. The investigation is being continued.

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(814) (a) WIND TUNNEL CLASSIFIER FOR SAND AND SILT.
(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Hunter Rouse and George H. Otto.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager, Hunter Rouse.
(f) Development of apparatus for the hydraulic separation of sediment to be used in routine experiments.
(g) Wind tunnel is 15 feet in length, and has flow section 2'-6" high and 2'-3" wide, bell entrance, and 1/10 HP duct fan at downstream end, with diaphragm throttle. Entire bottom consists of grid, below which are located 20 pans of various widths. External hopper permits continuous feed (60 to 100 lbs. per hour) in uniform sheet extending across flow section.
(h) Research completed. Paper by George H. Otto and Hunter Rouse entitled, "Wind-Tunnel Classifier for Sand and Silt" published in Civil Engineering, Vol. 9, No. 7, July, 1939.

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(815) (a) FIELD SAMPLING EXPERIMENTS ON BEACH SAND FROM MUSTANG ISLAND, TEXAS.
(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor, George H. Otto.
(f) To determine the relative significance which may be attached to the parameters of a single mechanical analysis of a natural sediment as illustrated by a beach sand.
(g) The outer beach at Mustang Island, Texas, was chosen because of its uniformity and relative freedom from local disturbing effects. (These data are compared with similar studies in California and Florida.) Four samples were collected at each of 22 stations along the beach of Mustang Island. The four samples were collected alongside each other but by somewhat different methods. All came from the same sedimentation unit. At one locality two sets, each consisting of 24 closely-spaced samples, were collected, using two of the four methods. All 136 samples were collected from the same part of the beach and from layers which appeared strictly comparable. Quantitative comparisons of average size, sorting, and skewness are made by means of parameters based on logarithmic moments of the sieve analysis following the method of Krumbein. The quantitative results are then interpreted in terms of the field conditions and the environment of deposition.
(h) The analytical work and the calculations are complete, and a report is being prepared.

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(831) (a) AN EXPERIMENTAL STUDY OF TURBULENT MIXING IN OPEN CHANNEL FLOW AND THE EFFECT ON THE SUSPENSION OF SEDIMENT.
(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) E. R. Van Driest.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) To obtain by direct measurement the variation of the fluid-mixing coefficient with depth in an open channel; and to determine the relation between the fluid-mixing coefficient and the sediment-mixing coefficient.
(g) Experiments will be performed in a closed-circuit steel flume, 10" wide, 10" deep, and 40' long, with an adjustable slope. A five-foot glass window permits photographic observations. Wide variation in the discharge is made possible by a variable-speed pump drive.

For a series of selected conditions of slope and channel roughness, the fluid-mixing coefficient will be investigated as a function of depth by photographic study of the diffusion of small immiscible globules introduced at a point in the flow.

Under the same conditions, sediment suspension measurements will be made, and by application of the theory of turbulent suspension to these measurements, a sediment mixing coefficient will be obtained. Also, for the same conditions, a mixing coefficient will be derived by means of application of momentum theory to shearing stress distribution in the body of the fluid.

Data obtained from all these measurements should yield significant information concerning the desired relationships.

(h) Construction of the flume is complete. Preliminary experiments are being made to work out photographic technique and to determine the number of observations necessary to obtain a mean value of the turbulent mixing at a point. Further preliminary experimentation is required to establish when this condition is reached.

(i) This project was listed in Bulletin VII, January, 1939, under Hydraulic Structures Laboratory, California Institute of Technology, with the title, "An Experimental Study of the Velocity Fluctuations in Turbulent Flow in Open Channels." Sponsorship of the project with slightly modified objective has subsequently been assumed by the Soil Conservation Service.

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(1099) (a) INFLUENCE OF SAMPLE WEIGHT AND SIEVING TIME ON SIEVE ANALYSES OF SANDS.

(b) Sedimentation Studies Division, Soil Conservation Service, U. S. Department of Agriculture.

(c) Cooperative research program with Soil Conservation Service.

(d) George H. Otto and Melvin Levet.

(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.

(f) To investigate the effects of different sieving times and sample weights on the logarithmic moment statistics of sieve analyses of quartz-feldspar sands; to evaluate the separate effects of average size, sorting, skewness, roundness, sieve interval, and influence of dust coatings.

(g) For each of a series of phi-normal sediments differing systematically in phi mean diameter and phi standard deviation, samples involving a 16-fold range of size are sieved for ratio-spaced time intervals varying from 37.5 seconds to 20 minutes. Tyler sieves, a Ro-Tap sieve shaker and improved Jones-type sample splitters are used. Sample splitting is so conducted that variations in composition arising therefrom can largely be eliminated mathematically from the sieve load effects. Effects of skewness, sieve interval, and dust coatings are studied separately on selected samples. Effect of roundness is obtained by using both well-rounded and angular quartz sands of essentially the same composition.

(h) Laboratory work is sufficiently advanced to show that the design of the experiment is satisfactory. It is anticipated that the results will lead to a rational approach to the question of optimum sieving time and sample weight.

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(1100) (a) CRITERIA FOR SIMILARITY IN THE TRANSPORTATION OF SEDIMENT.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Hunter Rouse.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) Development of similarity criteria for sediment that will be of use in laboratory studies of field problems involving erosion and sediment transportation.
(g) Similarity criteria developed by dimensional analysis and by analyzing the results of sediment transportation investigations were subjected to verification in a series of scour experiments. The erosion was produced on a horizontal bed of sand by a jet acting vertically downward. The removal of sand from the scour hole was observed through the glass walls of the tank. Sands of three sizes, but with the same sorting, were tested under different rates of discharge. In addition, each sand has been studied under a 1/2-scale reduction of all geometrical proportions except flume width.
(h) The study showed that in scour phenomena the ratio of settling velocity of the sediment to the mean velocity of flow is a basic criterion for similarity in model experiments. Investigation completed and report by Hunter Rouse published in proceedings of Meeting of the Society for the Promotion of Engineering Education.

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(1101) (a) A STUDY OF SCOUR BELOW DROPS.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) Brooks T. Morris.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) To establish a rational basis for the prediction of the rate of scour of natural or artificially placed sediments or pavements at the foot of drop structures, overfall dams, and natural waterfalls.
(g) Through the identification and individual evaluation of the variables (geometric, flow, fluid and sediment characteristics) in a scour-hole model, the rate of scour under varying conditions is to be established quantitatively. The model accomplishes scour through a jet directed vertically downward on the sediment bed.
(h) The nature of scour-hole growth in single-sized sediments has been explored and the method of transportation of the sediment identified. Experiments are being continued.

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(1102) (a) THE DEVELOPMENT OF METHODS OF DISSIPATING ENERGY BELOW DROPS.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) Walter L. Moore and Brooks T. Morris.
(e) Prof. Robert T. Knapp and Vito A. Vanoni, Project Supervisor.
(f) To study energy dissipation in a drop with a view to evaluating the effectiveness of the various design features of drop structures in producing stilling and minimizing down-stream erosion.
(g) The studies are carried on in a model having an 18-inch drop. The energy gradient through the structure is determined by velocity and surface profile measurements at sections in the structure. Investigations are made for different discharges and tail-water depths.
(h) Data has been obtained for 5 discharges and 5 tail-water depths. The investigation is being continued.

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(1103) (a) A STUDY OF ARMORED MUD BALLS.
(b) Sedimentation Studies Division, Soil Conservation Service, United States Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Hugh Stevens Bell.
(e) Prof. Robert T. Knapp, Vito A. Vanoni, Project Supervisor.
(f) To determine the origin of armored mud balls, their properties, and their contribution to transportation of bed load.
(g) Field and laboratory studies to determine (1) the relationship between total weight and the armor attained, (2) the influence of the distance traveled upon sphericity, and (3) the laws which govern the size of the balls.
(h) Study completed.
(i) Report by Hugh Stevens Bell published in the Journal of Geology, January-February, 1940. Title: "The Origin of Armored Mud Balls, Their Properties, and Their Role in Sedimentation."

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OHIO STATE UNIVERSITY.

(526) (a) DETERMINATION OF DISCHARGE COEFFICIENT OF FLOW NOZZLES.
(b) A.S.M.E. Special Research Committee on Fluid Meters.
(c) Calibration to determine accurately the coefficients of standard nozzles.
(e) Prof. S. R. Beitler.
(h) Laboratory work completed. Now assisting Committee in correlation of results and preparation of report.

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UNIVERSITY OF OKLAHOMA.

(617) (a) DETERMINATION OF DISCHARGE COEFFICIENTS FOR FLOW NOZZLES AND SQUARE-EDGED ORIFICES WHEN METERING OIL.
(b) Co-operative research project sponsored by the Special Research Committee on Fluid Meters of the A.S.M.E.
(c) Professor W. H. Carson, Dean, College of Engineering.
(f) To provide data on orifice discharge coefficients at low Reynolds numbers.
(h) Requested tests completed. Data sent to H. S. Bean, National Bureau of Standards, for analysis.
(i) Report for this Bulletin furnished by H. S. Bean.

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LEHIGH UNIVERSITY.

(1104) (a) STUDY OF DROP-INLET SPILLWAY AND STILLING BASIN.
(b) Department of Forests and Waters, Pennsylvania.
(c) Detail model study for Mont Alto Sanitorium Water Supply.
(d) A. T. Ippen; C. A. Lee.
(e) Professor A. T. Ippen.
(f) To study inlet flow conditions, pressure distribution in 90° bend below inlet, and stilling pool.
(g) Models of drop-inlet spillway and stilling basin built to scale ratio of 1:16 are employed.
(h) Under construction.
(i) To be finished in February.

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POLYTECHNIC INSTITUTE OF BROOKLYN.

(736) (a) STUDY OF CRITICAL DEPTH WEIR.
(c) Senior thesis.
(d) Walter J. Meditz and Ralph W. Gunwaldson.
(e) Prof. Chilton A. Wright.
(f) & (g) See Bulletin VII, January 1939.
(h) Project completed. Thesis on file at the Polytechnic Institute. See abstract in this bulletin.

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(1105) (a) STUDY OF FLOW IN INCLINED PIPES.
(b) The Waldo Smith Fellowship in hydraulics of the American Society of Civil Engineers.
(c) Master's thesis.
(d) Walter J. Meditz, Fellow.
(e) Prof. Chilton A. Wright.
(f) To determine and analyze the differences in the resistance to the flow of water in smooth pipes which are (1) horizontal, (2) inclined, and (3) vertical.

(g) A steel truss 28 ft long, pivoted at the center, has been constructed with freedom of rotation through 180°. Pipes ranging in size from 1 to 4 inches will be mounted on this truss and provided with suitable piezometer connections for measuring the loss of pressure and with a pitot tube for measuring the velocity distribution. Water will be supplied to the test pipe through a baffle tank at one end and later measured volumetrically in the laboratory.

It is planned to set a given quantity flowing through the pipe in a horizontal position and measure the velocity distribution and loss of pressure. Then the pipe will be rotated in a vertical plane, set at various angles, and the measurements repeated.

The results will be analyzed to study the effect of the gravitational field upon the flow in inclined pipes. It is hoped that information for practical use will be obtained.

(h) The truss is assembled and the other parts of the apparatus are being constructed.

(i) It is planned to complete this project by next September.

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CORPS OF ENGINEERS, BONNEVILLE HYDRAULIC LABORATORY.

(917) (a) MODEL STUDY OF THE SPILLWAY OF MUD MOUNTAIN DAM.
(b) The Division Engineer, North Pacific Division, Portland, Oregon.
(c) Study of a spillway structure.
(d) Laboratory staff under the direction of Robert D. Cochrane, Associate Engineer.
(e) The District Engineer, U. S. Engineer Office, Bonneville, Oregon.
(f) To determine the hydraulic characteristics of the spillway as originally designed, and to develop means of correcting any undesirable features.
(g) The model was constructed to a scale of 1:50, with the spillway structure built of waterproofed plywood, and the dam, upper pool, and downstream canyon reproduced in concrete. Observations of spillway capacity, water surface profiles, velocities, pressures, and general flow conditions were made.
(h) All testing has been completed. The results of these tests have been presented in two preliminary reports, dated September 11, 1939, and December 1, 1939, respectively.
(i) It is intended to issue, within the next six months, a final report covering the results of the entire model study.

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(1106) (a) MODEL STUDY OF THE NAVIGATION CHANNEL CONDITIONS ON THE COLUMBIA RIVER AT BONNEVILLE, OREGON.
(b) The District Engineer, U. S. Engineer Office, Bonneville, Oregon.
(c) Study of plans for improving navigation channel conditions.
(d) and (e) See (917).
(f) To determine the most satisfactory plan for the elimination of undesirable current conditions at the lower end of the downstream lock approach channel of Bonneville Dam.

(g) The model is of the fixed-bed type, is constructed to a horizontal scale of 1:200 and a vertical scale of 1:100, and reproduces a five-mile reach of the river below Bonneville Dam. Flows from low water to maximum flood are simulated, especial attention being paid to flows greater than 300,000 cfs. The plans to be tested involve realignment of the north shore of the main channel, realignment of the south shore of the lock approach channel, and installation of dikes -- all in conjunction with the proposed enlargement of the tailrace channel. Observations upon current directions, velocities, and water surface slope profiles will be made.

(h) The model has been designed and constructed, and the verification tests have been completed. Tests of improvement plans are now in progress.

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(1107) (a) MODEL STUDY OF THE REGULATED TUNNEL OF MUD MOUNTAIN DAM.
(b) The Division Engineer, U. S. Engineer Office, Portland, Oregon.
(c) Study of a tunnel structure.
(d) and (e) See (917).
(f) To ascertain the hydraulic characteristics of the designed tunnel and to develop means of correcting any unsatisfactory features.
(g) The model is constructed to scale of 1:25. The intake structure, the tunnel of some 1,600 ft in length, the regulating valves on the penstock, and the canyon in the vicinity of the outlet will be reproduced in the model. The tunnel proper is to be made of pyralin to permit observation of flow conditions. Rating curves for the tunnel will be established, and data on pressures and general flow characteristics will be taken.
(h) The design of the model has been completed and construction is in progress.

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(1108) (a) MODEL STUDY OF WILLAMETTE FALLS LOCKS.
(b) The District Engineer, U. S. Engineer Office, Portland, Oregon.
(c) Study of the operation of a system of two locks.
(d) and (e) See (917)
(f) To study the operation characteristics of the designed lock system, and to determine what changes, if any, may be required to increase the efficiency of these structures.
(g) The model will be constructed to a scale of 1:25, and the following items reproduced: a portion of the upstream or guard lock, inclusive of culvert and outlet ports; the boat basin between the guard lock and the main lock; the siphon spillway in the boat basin; and the entire main lock. A 1:10 scale model of one unit of the siphon spillway will be used to determine the detailed action of that structure. The capacity of the siphon spillway will be investigated, and filling, emptying, and surge characteristics of the main lock will be determined. Surge action in the boat basin will be ascertained.
(h) The design of the model has been initiated.

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(1109) (a) PRESSURE HEAD INVESTIGATION ON BONNEVILLE SPILLWAY DAM.
(b) The Division Engineer, U. S. Engineer Office, Portland, Oregon.
(c) Comparison of prototype and model pressures on spillway ogee section.
(d) and (e) See (917).
(f) To determine the pressure conditions on the crest and downstream face of the Bonneville Spillway Dam, and compare with the results of a previously-conducted model study, special attention being paid to negative pressures. A series of observations were conducted on one of the bays of the Bonneville Spillway Dam during low tailwater conditions. Water surface elevations below the gate and pressures on the face of the ogee section were taken with the gate on the crest of the spillway set at various openings in both the upstream and downstream slot. A comparison will be made between these observations and similar observations taken on the 1:5 scale model of this spillway which was studied at the Hydraulic Laboratory at Limnton, Oregon, during the period of April 1935 to January 1937.
(h) The procurement of field data has been completed, and the preparation of the report is now in progress.

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U. S. GEOLOGICAL SURVEY.

(1110) (a) POSITION OF ENGINEER IN MAKING CURRENT-METER MEASUREMENTS BY WADING.
(b) United States Geological Survey, Water Resources Branch.
(c) Experimental research for improvement of technique in use of current meters.
(d) C. H. Pierce and A. D. Ash.
(e) C. H. Pierce, U. S. Geological Survey, Washington, D. C.
(f) To ascertain the extent to which current-meter observations of velocities may be affected by a person standing in the water in the vicinity of the meter, and the position that should be taken by the engineer in making discharge measurements by wading in order to avoid or minimize the possibility of affecting the velocity of the water passing the current meter.
(g) Tests made in the 12-foot wide flume in the National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C. Observations made at various depths and velocities, and for different positions and distances between the current meter and the person standing in the water.
(h) Work is just being started.

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(1111) (a) STUDIES OF ARTIFICIAL CONTROLS FOR STREAM-MEASUREMENT STATIONS.
(b) United States Geological Survey, Water Resources Branch.
(c) Tests of 1/6th scale models of various types of artificial controls.
(d) C. H. Pierce and A. D. Ash.
(e) C. H. Pierce, U. S. Geological Survey, Washington, D. C.
(f) To obtain information regarding performance under high heads and large percentages of submergence.

(g) Tests made in the 20-inch wide glass-sided flume in the National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C. Observations of pressure heads at various points on the control and in the flume above and below the control.
(h) Tests of some models have been completed. Other models have been constructed and are ready for tests.
(i) These tests are supplementary to tests of full-size models previously made in the National Hydraulic Laboratory. Investigations are also being made of other types of controls not previously tested.

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BUREAU OF RECLAMATION, Hydraulic Structures Laboratory.

(46) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE BOULDER DAM.
(b) Bureau of Reclamation.
(c) Specific design investigation.
(d) Hydraulic structures laboratory, Bureau of Reclamation.
(e) Chief Engineer, Bureau of Reclamation, Denver, Colorado.
(f) Experiments to complete information desired on shapes of overfall dams and coefficients of discharge.
(g) The method consists of using a sharp-edged weir placed at several angles in the channel (similar to the work of Bazin about 1890 but much more extensive) and measuring the upper and lower nappe shapes of the overfalling sheet of water for various discharges and approach depths. The data are compiled in dimensionless form for use in the design of overfall dams of any size. From this information the designer will have the most efficient as well as the most economical section from which to base spillway designs.
(h) Testing on the vertical face weir has been completed. The work on the sloping weirs is progressing intermittently.
(i) A report on the vertical face weir has been prepared as a thesis and submitted for an advanced degree from the University of Colorado in 1939 by Jacob E. Warnock, Hydraulic Engineer. A copy is available for loan in the Bureau of Reclamation Library at Denver, Colorado. This material will also be included as Part VI, Bulletin 3 of the Boulder Canyon Final Reports when published.

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(547) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE GRAND COULEE DAM.
(b) (c) (d) (e) Same as (46).
(f) Study of the hydraulic features of the dam.
(g) Models of spillway section and bucket tested on three scales; a model of the construction stages to study alternate diversion sequences to avoid adverse erosion below dam; model tests to design the three tiers of outlets; tests relating to the de-icing of trashracks by subsurface air release; and a river model on a 1:120 scale of the Little Dalles of the Columbia River.
(h) Testing has been completed on all except the last model. Reports are in preparation.

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(548) (a) IMPERIAL DAM AND ALL-AMERICAN CANAL STRUCTURES.
(b) (d) (d) (e) Same as (-8).
(f) To check and improve the designs of Imperial Dam and its appurtenant features and various types of hydraulic structures on the All-American Canal.
(g) Models to study pressure conditions on face of dam; to design stilling basins for spillway and sluiceways; to design ejectors to remove seepage water from within dam; a complete model of Imperial Dam and reservoir to study silt movement at intake to All-American Canal; various problems in connection with the All-American Canal desilting works; and models to check the design of overchutes, wasteways and drop structures on the All-American Canal.
(h) Testing has been completed except for a few problems on canal structures. Reports are in preparation.
(i) The information from these tests will be published in Part VI of the final reports on the Boulder Canyon Project.

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(549) (a) CALALLO DAM SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) To check and improve the design of spillway, outlet control gates, and transition; stilling basins for spillway and outlets; and develop a satisfactory flow-measuring device for the outlet works.
(g) A model of the spillway and another of the outlet works were used.
(h) A report on this work is being prepared.
(i) Principal features of this work are the demonstration of the inadequacy of the trapezoidal stilling pool and of the effectiveness of various factors in quieting the flow from the outlets.

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(350) (a) BULL LAKE DAM AND OUTLET WORKS.
(b) (c) (d) (e) Same as (-).
(f) Improvement of spillway design; study of gate and transition section in outlet tunnels with adequate air vents to maintain free flow; and design of stilling pool at outlet of tunnels.
(g) Two models were used, one of the spillway and one of the outlet works.
(h) This work is reported in Bureau of Reclamation Technical Memorandum 556 by J. M. Buswell and D. C. Weed.
(i) A novel feature of the outlet design is a vertically curved hump in the floor immediately downstream from exit. Water from the tunnels rises and spreads laterally as it passes over the hump, descending into the stilling pool in a well-distributed sheet.

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(554) (a) DANIELL DAM SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) Study of the design of a curved super-elevated spillway channel and calibration of needle valves and rectangular sluiceways in the outlet works.
(g) Four models were employed in performing these studies: one of the spillway by which a method of computation was developed for super-elevated channels; one of a 66-inch needle valve on a scale of 1:8 from which a prototype calibration was performed in the laboratory; and two rectangular sluiceway models on different scales from which a prototype calibration was also made from models in the laboratory.
(h) The work has been completed and the report is in preparation.

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(699) (a) MARSHALL FORD DAM SPILLWAY AND OUTLET WORKS.
(b) Colorado River Authority, Texas.
(c) (d) (e) Same as (28).
(f) Study and improvement of spillway and outlet designs.
(g) Model tests to develop a stilling basin to function when either the spillway or the outlets are discharging.
(h) Studies are completed and report will be completed about March 1940.

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(779) (a) ROZA DIVERSION DAM AND APPURTENANT STRUCTURES.
(b) (c) (d) (e) Same as (48).
(f) Study of hydraulic design of roller gates, overflow section, canal intake, and fish ladder.
(g) A single model including all of the above features.
(h) Completed and report published as Bureau of Reclamation Technical Memorandum 594, byH. G. Dewey, Jr., Assistant Engineer.

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(919) (a) SHASTA DAM SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) Study of the design of spillway and outlet works and determination of best layout for powerhouse.
(g) Two models of the spillway have been employed to date, a sectional model on a 1:40 scale and a complete layout on a 1:68 scale. In addition, a pyralin model on a scale of 1:17 is being used to study the outlet design.
(h) Testing is in progress.

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(920) (a) FRIANT DAM SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) Study to improve the design of the spillway and outlet works.
(g) A sectional model on a 1:24 scale and a complete model on a 1:60 scale have been used in the work on the spillway. Two other models, one representing a single outlet on a scale of 1:17 and the other a model containing four valves discharging into a stilling basin, have been indispensable in studying the outlet design.
(h) Testing is in progress.

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(923) (a) HEAD GATE ROCK DAM SPILLWAY.
(b) Indian Service.
(c) (d) (e) Same as (48).
(f) To check hydraulic design of gate section, chute, and stilling basin.
(g) Model on 1:60 scale.
(h) Studies completed. Report by R. A. Goodpasture, Assistant Engineer, available at Bureau of Reclamation, Denver, Colorado.

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(1112) (a) WICHUP DAM OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) Study to improve the design of outlet stilling basin.
(g) Model on 1:20 scale.
(h) Work completed. Report by J. H. Douma, Assistant Engineer, available at Denver office of Bureau of Reclamation.

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(1113) (a) CONCHAS DAM IRRIGATION OUTLET WORKS.
(b) (c) (d) (e) Same as (48).
(f) Study to improve design of outlet stilling basin leading to irrigation canal.
(g) Model on 1:15 scale.
(h) Work completed. Report by H. G. Dewey, Jr., Assistant Engineer, available at Denver office.

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(1114) (a) SUNNYSIDE CANAL CHECK-DROP STUDY.
(b) (c) (d) (e) Same as (48).
(f) To improve design of existing structure in field.
(g) Model studies.
(h) Report by H. G. Dewey, Jr., written as a thesis for a Master's Degree from University of Colorado. A copy is on file at the Denver office of the Bureau of Reclamation.
(i) A model of the check-drop was first constructed as it existed in the field. Results from the two seurces were strikingly similar. A series of revisions were then made on the model until a satisfactory solution was developed.

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(1115) (a) LAHONTAN DAM SPILLWAY.
(b) (c) (d) (e) Same as (48).
(f) To check design of spillway as it exists in the field before making needed repairs.
(g) Model tests.
(h) Work completed. Report in preparation.

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(1116) (a) ARROWROCK DAM POWER PENSTOCKS.
(b) (c) (d) (e) Same as (48).
(f) To investigate cause of cavitation which occurs in power penstocks now being used as outlets.
(g) Model tests in laboratory.
(h) Testing in progress.

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(924) (a) GRAND COULEE POWER PLANTS DRAFT TUBES.
(b) U. S. Bureau of Reclamation.
(c) Model studies of draft-tube performance.
(d) Hydraulic machinery laboratory.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.
(f) Selection of most favorable draft-tube design.
(g) Selection based on the efficiency of an homologous turbine model as affected by various draft-tube designs.
(h) Completed. Report in preparation.

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(925) (a) GRAND COULEE PUMPING PLANT INTAKE.
(b) U. S. Bureau of Reclamation.
(c) Model study of hydraulic losses and flow conditions from trash racks to pump impeller eye.
(d) and (e) Same as in (924).
(f) To reduce losses and obtain uniform flow distribution into the pump impeller.
(g) Transparent models for both visual and quantitative study.
(h) Completed. Report available on loan.

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(926) (a) CIRCULAR SLUICE ENTRANCES.
(b) U. S. Bureau of Reclamation.
(c) Model study for design data.
(d) and (e) Same as in (924).
(f) To develop a sluice entrance design which will not cavitate when operating under high heads.
(g) The sluice entrance was designed to conform approximately to the outline of a free jet flowing through a circular sharp-edged orifice.
(h) Test completed. Report available on loan.

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(927) (a) PENSTOCK RELIEF VALVES AND ENERGY ABSORBERS.
(b) U. S. Bureau of Reclamation.
(c) Model study for design data.
(d) and (e) Same as in (924).
(f) To correct defects in designs now in use and to develop new design.
(g) By means of transparent models for visual and quantitative study.
(h) Report on first series completed. Second series of tests now in progress.

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(928) (a) NEEDLE VALVE CAVITATION.
(b) U. S. Bureau of Reclamation.
(c) Model studies at low and high heads.
(d) and (e) Same as in (924).
(f) To determine optimum operating characteristics with regard to discharge and cavitation.
(g) By means of bronze model and a transparent sectional model to study the performance both visually and quantitatively.
(h) Tests completed. Report material available on loan.
(i) Tests were run on a 5-inch valve for a period of several months at high heads. The effect of cavitation was recorded for several types of needles at various rates of discharge.

.....

(929) (a) SEALS FOR PENSTOCK HEAD GATES AND SLUICE GATES.
(b) U. S. Bureau of Reclamation.
(c) Tests of various designs of sealing devices.
(d) and (e) Same as in (924).
(f) To develop an effective seal for high-pressure gates.
(g) Full-scale sections of seals operated hydraulically.
(h) Tests complete. Report in progress.

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(930) (a) BENDS AND ELBOWS IN LARGE PENSTOCKS.
(b) U. S. Bureau of Reclamation.
(c) Laboratory studies for design data.
(d) and (e). Same as in (924).
(f) To study hydraulic characteristics of various new types of bends.
(g) Transparent models.
(h) Tests now in progress.

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(1117) (a) GRAND COULEE PUMPING PLANT DISCHARGE SYPHONS.
(b) U. S. Bureau of Reclamation.
(c) Laboratory studies for design purposes.
(d) and (e) Same as in (924).
(f) To determine transient characteristics of the pump discharge line and syphons and to prevent scour at discharge end of syphons.
(g) Transparent model.
(h) Tests now in progress.

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U.S. WEATHER BUREAU.

(1118) (a) CHERRY CREEK BASIN, DENVER, COLORADO.
(b) Flood Control Coordinating Committee, U.S.Department of Agriculture.
(c) Cooperative study with the Flood Control Coordinating Committee.
(d) and (e) Hydrometeorological Section, River and Flood Division, U. S. Weather Bureau.

(f) To determine the point rainfall intensity-frequency, and areal rainfall intensity-frequency of expected storms over the watershed. Such data are necessary for the adequate and economical planning of runoff and waterflow retardation and soil prevention measures to be adopted for flood control purposes.

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(1119) (a) PAJARO RIVER BASIN, CALIFORNIA.
(b), (c), (d), (e), (f) See (1118).

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(1120) (a) GRAND NEOSHO BASIN, KANSAS-OKLAHOMA.
(b), (c), (d), (e), (f) See (1118).

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(1121) (a) PEE DEE BASIN, SOUTH CAROLINA.
(b), (c), (d), (e), (f) See (1118).

.....

(1122) (a) PECOS BASIN, TEXAS-NEW MEXICO.
(b), (c), (d), (e), (f) See (1118).

.....

(1123) (a) YOUGHIOGHENY BASIN, PENNSYLVANIA.
(b), (c), (d), (e), (f) See (1118).

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(1124) (a) POTOMAC RIVER BASIN.
(b), (c), (d), (e), (f) See (1118).

.....

(1125) (a) CODORUS CREEK, PENNSYLVANIA.
(b), (c), (d), (e), (f) See (1118).

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(1126) NORTH CONCHO RIVER, TEXAS.
(b), (c), (d), (e), (f) See (1118).

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(1127) (a) MAXIMUM POSSIBLE RAINFALL OVER THE CONNECTICUT-PASSUMPSIC BASIN, VERMONT.
(b) Corps of Engineers, U. S. Army.
(c) Flood control works.
(d) Hydrometeorological Section, River and Flood Division, U. S. Weather Bureau.
(e) Same as (d).
(f) To determine maximum possible storm for use in design of flood works.

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TENNESSEE VALLEY AUTHORITY.

Items (b), (d), and (e) are the same for projects (494) to (1136), inclusive. They have been omitted from the individual projects to avoid unnecessary repetition. Their significance is as follows:

(b) Tennessee Valley Authority.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority, Knoxville, Tennessee.

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(494) (a) PICKWICK LANDING DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and shape of crest for Pickwick Landing Dam.
(f) To determine a satisfactory and economical design of apron below the dam in order to dissipate energy, and to determine the best shape of spillway crest.
(g) Tests made on models built to three different scales. Action of stilling basin for 1:50 and 1:25 sectional models observed through glass panels in side of flume. Results checked on 1:100 model of entire dam. Discharge coefficients, pressures on face of spillway, and on spillway gate piers for various combinations of gate operation were carefully measured on a 1:25 model. Supplementary studies were also made to determine the size of air passages necessary for satisfactory aeration of the nappe.
(h) Tests completed.
(i) Report in progress.

.....

(495) (a) PICKWICK LANDING DAM COFFERDAMS.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, navigation, and scour; to determine the allowable constriction of the river channel by cofferdams in each of the various stages of construction.
(g) A model of 9000 feet of the Tennessee River including the dam site was built to a scale of 1:100. 3800 feet of the channel at the site was formed in fine sand in order to investigate scouring conditions. Scale models of all proposed construction features such as cofferdams, lock, power house, and spillways were put in place to simulate various proposed phases of construction, and the effects on the river were observed in order to determine the best sequence of operations.
(h) Tests completed.
(i) Report completed.

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(574) (a) HIWASSEE DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Hiwassee Dam.
(f) To determine the most satisfactory and economical design of stilling basin at the toe of the dam, and to measure spillway discharge coefficients.
(g) Tests were made on a 1:55 scale model placed behind a glass panel to allow visual observation of erosion in the bed below the stilling basin.
(h) Tests completed.
(i) Report in progress.

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(577) (a) HEAD INCREASER, POWER HOUSE.
(c) Investigation of a combined spillway and power-house unit whose object is increasing the effective head on the turbines by utilizing the surplus flood waters to reduce the back pressure on the draft tubes.
(f) To determine feasibility of application of the scheme to dams on the Tennessee River.
(g) Tests were made on a 1:50 scale model. Provision was made for changing the proportions and dimensions of the spillway sluices, draft tubes, and tailrace. Transparent sections allowed visual observation of flow conditions.
(h) Tests completed.
(i) Report completed.

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(708) (a) GUNTERSVILLE DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Guntersville Dam.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion, and to determine spillway discharge coefficients.
(g) Tests of the apron design were made on a 1:25 scale model of 3 spillway bays in a flume with glass panels which permitted observation. The final design was checked on a 1:100 scale model of the entire spillway. Discharge coefficients were determined on models at scales of 1:25 and 1:50.
(h) Tests completed.
(i) Report in progress.

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(709) (a) CHICKAMAUGA DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Chickamauga Dam.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion, and to determine spillway discharge coefficients.

(g) Tests of the apron design were made on a 1:25 scale model of 3 spillway bays in a flume with glass panels which permitted observation. The final design was checked on a 1:100 scale model of the entire spillway. Discharge coefficients were determined on models at scales of 1:25 and 1:50.
(h) Tests completed.
(i) Report in progress.

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(710) (a) CHICKAMAUGA DAM, COFFERDAM.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, velocities, and scour; to determine the allowable constriction of the river channel by cofferdams in the various stages of construction.
(g) A model of about 2 miles of the Tennessee River at the site of Chickamauga Dam was formed in fine sand at a scale of 1:110 in order to investigate scouring conditions. The bed was paved with concrete to measure velocities and backwater effects. Scale models of proposed construction features such as cofferdams, locks, and spillways, were installed to simulate various phases of construction.
(h) Tests completed.
(i) Report completed.

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(781) (a) KENTUCKY (FORMERLY GILBERTSVILLE) LOCK, FILLING SYSTEM.
(c) Investigation of various types of filling systems for Kentucky Dam Lock.
(f) To develop the simplest, most effective, and most economical scheme of filling system.
(g) Tests were made on a 1:36.67 scale model of Kentucky Dam Lock. Systems tested include the conventional culvert and port system with various spacings of ports, short culverts by-passing the upper sill, and a tainter gate which served to close the lock as well as to regulate filling. The effectiveness of the various schemes was determined by measuring the hawser stresses required to hold a model barge tow in place during filling. A continuous record of barge motion, water levels, and hawser stresses was obtained.
(h) Tests completed.
(i) Report completed.

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(782) (a) NAVIGATION BELOW PICKWICK LANDING DAM.
(c) Investigation of proposed dredging program on navigability of shoals below Pickwick Landing Dam.
(f) To determine the effectiveness of a proposed dredged channel in facilitating navigation through the shoals below Pickwick Landing Dam.

(g) A model of approximately 11 miles of the Tennessee River below Pickwick Landing Dam was built to a horizontal scale of 1:300 and a vertical scale of 1:60. The proposed dredging was reproduced and its effect on navigation was determined by observation of currents and operation of a model barge tow.
(h) Tests completed.
(i) Report completed.

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(939) (a) HIWASSEE DAM, CAVITATION AT SLUICE ENTRANCES.
(c) Investigation of possibility of cavitation at entrance of discharge sluices.
(f) To develop an entrance shape which would prevent cavitation under all normal operating conditions.
(g) A 1:15 scale model of the upper portion of the sluice, including the entrance, was built and provided with piezometer connections along its length and at all points where local pressure reductions might occur. Pressures were measured for test conditions simulating various reservoir elevations and discharges.
(h) Tests completed.
(i) Report in progress.

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(940) (a) HIWASSEE DAM, EMERGENCY SLUICE GATE.
(c) Investigation of shape of gate as affecting hydraulic down-pull on gate during closure.
(f) To design the gate so as to reduce the hydraulic load during closure, and consequently the hoist capacity, as far as possible.
(g) A 1:15 scale model of the emergency gate was built and tested in place on a model of the sluice entrance. The effectiveness of a number of designs was determined by weighing the hydraulic load. Pressure measurements on the face of the gate and on the gate beams aided in designing for reduced load.
(h) Tests completed.
(i) Report completed.

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(943) (a) NORRIS SPILLWAY DISCHARGE COEFFICIENTS.
(c) Determination of Norris Spillway discharge coefficients and comparison with results of tests on 1:72 scale model.
(f) To rate the Norris spillway and to determine the correspondence of the 1:72 scale model with its prototype.
(g) Observations of depth of flow over crest were made during release of January and February, 1937. Discharges were measured at a USGS rating station just below the dam.
(h) Work completed.
(i) Report completed.

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(945) (a) PICKWICK LANDING DAM, LOCK-WALL EXTENSION.
(c) Study of effect of proposed lock-wall extensions in quieting waves in lock approach.
(f) To determine the most economical method of reducing wave height in the approach to Pickwick Landing Lock.
(g) Tests made on guard wall extensions of varying character, solid and permeable, on a 1:100 scale model. Several types of floating boom designed to reduce waves were tested at scales of 1:100, 1:30, and 1:6.4.
(h) Tests completed.
(i) Report completed.

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(947) (a) KENTUCKY DAM (FORMERLY GILBERTSVILLE), COFFERDAM.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, navigation, and scour; to determine the allowable constriction of the river channel by cofferdams in each of the various stages of construction.
(g) A model of 10,000 feet of the Tennessee River was built at a scale of 1:100. The river bed was molded in fine sand so that scour could be observed. Structures, including lock, powerhouse, spillway, and cofferdams were made removable so that the effects of various arrangements could be tried.
(h) Tests completed.
(i) Report completed.

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(948) (a) WATTS BAR DAM, NAVIGATION STUDY.
(c) Investigation of navigation conditions below Watts Bar Dam.
(f) To determine the best arrangement of structures for Watts Bar Dam from the standpoint of navigation.
(g) A model of 12,000 feet of the Tennessee River at the dam site was built at a scale of 1:100. Models of structures were removable so that different arrangements could be studied. The effect of spillway and powerhouse operation on boats entering the lock from below were of particular interest.
(h) Tests completed.
(i) Report completed.

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(1126) (a) CHICKAMAUGA DAM, LOCK WALL EXTENSION.
(c) Investigation of methods of improving navigation conditions in the downstream lock entrance.
(f) To determine the form and extent of an extension to the river lock wall to protect the lower lock approach from wave effects.
(g) Tests were made on a 1:110 scale model with various forms of extension to the lower lock guard wall in place. Observations were made to determine the effect on currents and wave heights. Floating booms were studied as well as permanent structures. The effect of various methods of spillway gate operation on navigation was also investigated.

(h) Tests completed.
(i) Report completed.

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(1129) (a) KENTUCKY DAM, SPILLWAY DESIGN.
(c) Investigation of spillway section and apron for Kentucky Dam.
(f) To develop the most suitable form of spillway section, apron, and stilling basin to provide for: (1) the safety of the dam against erosion at the toe, (2) the minimum disturbance of the thick gravel deposits overlying the rock in the river bottom, (3) a minimum interference with navigation by waves and adverse currents.
(g) Tests are being made on a 1:30 scale model of three spillway bays in a flume with glass panels which permit observation. This model is used to develop the shape of crest and stilling basin, and to provide general information regarding the movement of river bed material and the formation of waves on the water surface. The entire dam and a portion of the river is modeled to a scale of 1:121 in order to make a more detailed study of the effects of gate operation and apron design on movement of bed material and on navigation.
(h) Preliminary tests have been carried out on the 1:30 scale model, and the 1:121 scale model is under construction.

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(1130) (a) GUNTERSVILLE DAM, COFFERDAM.
(c) Investigation of effect of construction operations and cofferdamming on backwater, scour, and navigation during construction of Guntersville Dam.
(f) To determine the effect of proposed cofferdams on river stages, navigation, and scour during the construction period.
(g) A model of the river was built to a scale of 1:150 and included about one mile above and one-half mile below the dam. The topography was molded in fine sand. Scale models of all proposed structures which would affect flow during construction were built and put in place. Observations were made to determine for the second and third stages of construction: the discharges which would overtop the cofferdams; the probable location and extent of scour; and the effect on navigation, particularly in the lock approaches.
(h) Tests completed.
(i) Report completed.

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(1131) (a) GUNTERSVILLE LOCK, FILLING SYSTEM.
(b) Investigation of characteristics of lock-filling system as predicted by model.
(f) To obtain data on the operation of a model which later might be compared with similar data obtained on the prototype.
(g) Tests were made on a 1:20 scale model of Guntersville Lock. The filling time and distribution of flow among the filling ports were determined for lifts of 34 and 39 feet. Stresses in the mooring hawsers were measured for each lift for barge tows having drafts of 6 feet and 9 feet.

(h) Tests completed.
(i) Report completed.

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(1132) (a) GUNTERSVILLE DAM, LOCK-WALL EXTENSION.
(c) Investigation of methods of improving navigation conditions in the downstream lock entrance.
(f) To determine the amount and type of extension to the lower lock guard wall needed to ensure satisfactory navigation conditions in the downstream lock entrance.
(g) Tests were made on a 1:110 scale model of the entire dam. The river was reproduced for a distance of 3500 feet upstream and 1200 feet downstream from the dam. Several types of wall extension were studied to determine their effectiveness in reducing wave heights and in suppressing adverse currents. The effect of various methods of gate operation on currents was also investigated.
(h) Tests completed.
(i) Report completed.

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(1133) (a) NORRIS DAM, SLUICE CALIBRATION.
(c) Calibration of sluices for discharge.
(f) To obtain accurate data for discharge rating of sluices.
(g) Gate openings and pool levels obtained from operating records at the dam have been correlated with the river discharge at a gaging station immediately below the dam. Additional measurements needed to fill gaps in the data will be made when the sluices are again placed in operation.
(h) All data now available have been utilized. Work will be resumed when further releases are made through the sluices.

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(1134) (a) WATTS BAR LOCK, FILLING SYSTEM.
(c) Investigation of filling system for Watts Bar lock.
(f) To determine the most satisfactory size of culvert and number of spacing of ports in the filling system of Watts Bar lock and to study conditions at the outlet of the lock-emptying system.
(g) A model was built at a scale of 1:20 in such a manner that the entire filling system could be changed easily. The effectiveness of a filling system was measured by the stresses required to moor a tow during filling. An automatic recording device made a continuous record of upper pool level, culvert valve opening, lock-chamber water level, longitudinal hawser stress, and transverse bow and stern stresses. The distribution of flow in the culvert and port system was also determined. The operation of the outlet for the emptying system was studied carefully on a 1:121 scale model of the entire river. Attention was paid chiefly to the possibility of scour at the outlet structure.
(h) Tests completed.
(i) Report completed.

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(1135) (a) WATTS BAR DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and shape of crest for Watts Bar Dam.
(f) To develop an apron which would cause a minimum of disturbance to navigation and eliminate scouring where it would be harmful to structures.
(g) Shape of crest and tentative apron design were developed on a 3-bay model built at a scale of 1:25 in a flume provided with glass panels which permitted observation. The effects of the apron design and various methods of gate operation on navigation were observed on a 1:121 scale model of the entire dam. Particular attention was paid to the presence and size of waves which might have an adverse effect on navigation.
(h) Tests completed.
(i) Report in progress.

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(1136) (a) WILSON DAM, SPILLWAY DISCHARGE.
(c) Study of discharge over Wilson Dam spillway.
(f) To provide a satisfactory discharge rating for Wilson Dam crest gates.
(g) Tests were made on 3 bays of Wilson Dam spillway at a scale of 1:39.4. Discharges were measured for all gate openings and reservoir elevations over the entire operating range. Measurements were made for all 3 gates discharging and for the center gate alone. Profiles of the water surface between the piers were obtained and compared with similar measurements made on the prototype.
(h) Tests completed.
(i) Report in progress.

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B. CURRENT HIDROLOGICAL AND HYDRAULIC FIELD INVESTIGATIONS.

Items (b) and (e) are the same for projects (950) to (963), inclusive. Their significance is as follows:

(b) Tennessee Valley Authority.
(e) Albert S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority.

(950) (a) DETERMINATION OF SILT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.
(d) Hydrography Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine the quantity of silt carried by streams from which to estimate life of reservoirs, and to furnish data on relative erosion from various areas and planning of corrective measures.
(g) Samples of water are collected periodically at stations in the Basin, analyzed to determine the suspended silt content, and correlated with river discharge to determine the suspended silt load at each station.
(h) Data are being collected.

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(951) (a) EVAPORATION IN THE TENNESSEE RIVER BASIN.
(c) A study of the evaporation of water from reservoir surfaces.
(d) Hydrology Section, Hydraulic Data Division, under direction of Robert W. Gay.
(f) To derive a general rule applicable to the Tennessee River Basin that will permit the computation of evaporation from known meteorological phenomena.
(g) Accurate daily measurements are made of evaporation from a pan at four locations in the Basin, together with readings of standard meteorological equipment.
(h) The stations were established between October 1934 and April 1935, and continuous records have been kept.

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(955) (a) GROUND-WATER INVESTIGATIONS.
(c) Hydrological study.
(d) Hydrography Section, Hydraulic Data Division, under direction of G. N. Darrell.
(f) To determine effect of filling of reservoirs on adjacent water table.
(g) Observation wells are dug, and the record of the level of the water in these wells is compared with rainfall and river stages for periods before and after reservoir filling. Studies are being made for Chickamauga, Guntersville, Pickwick, Watts Bar, Wheeler, and Kentucky Reservoirs.
(h) Installations are complete, and records are being collected. Preliminary reports are being prepared for the projects at which construction work is nearing completion.

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(956) (a) FLOOD INVESTIGATIONS - TENNESSEE RIVER AND TRIBUTARIES.
(c) Survey to obtain field data for hydraulic studies.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To provide data on past and current floods necessary in planning flood-control projects.
(g) High-water marks are set and observations made as current floods occur; field search is made for high-water marks of past floods and data collected on rainfall-runoff and damages during such floods.
(h) Work is in progress.
(i) Report in progress.

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(958) (a) INVESTIGATION OF SPRINGS AND RUNS BELOW DAMS.
(c) Hydrologic investigation having application to construction activities.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To measure flows from springs and runs below dam sites before and after construction of dams to determine leakage.

(g) Measuring weirs were constructed at Tennessee Valley Authority dams and are observed regularly. The records are being analyzed to account for current rainfall.
(h) Observations are being continued.

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(959) (a) PRECIPITATION IN TENNESSEE RIVER BASIN.
(c) A comprehensive study of rainfall and other weather phenomena in and adjacent to the watershed.
(d) Hydrology Section, Hydraulic Data Division, under direction of Robert W. Gay.
(f) To furnish meteorological data for use in planning water-control projects, for agricultural and other purposes.
(g) Records from 421 TVA, U. S. Weather Bureau, and private rain gages in Tennessee Valley are collected, compiled, and analyzed. Special investigations are made of unusual storms.
(h) Bulletins are issued monthly presenting the data collected.

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(960) (a) RESERVOIR TEMPERATURES.
(c) Hydrographic investigation to obtain data on reservoir water temperatures.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To determine the variations of water temperature from the surface to the bottom in the entire body of water throughout the year for use in connection with water utilization.
(g) Established ranges on Norris, Wheeler, Pickwick, and Guntersville Reservoirs are sounded monthly with a resistance thermometer, and readings are taken at every 5 or 10 feet of depth.
(h) Monthly records are obtained. Reports are prepared periodically.

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(961) (a) RUNOFF-SILT INVESTIGATIONS ON SMALL WATERSHEDS.
(c) Hydraulic-hydrological research to give data on runoff and silt erosion from areas of varying degrees of forest cover.
(d) Hydrography Section and Field Investigations Section, Hydraulic Data Division, under direction of G. H. Burrell and J. E. Goddard.
(f) To determine the relation between rainfall, runoff, and silt over three small tributaries of Norris Reservoir that have been selected for forest influence studies.
(g) Rainfall, runoff, and silt data are collected and studied for individual storm periods, and correlations are made between rainfall and peaks of discharge and silt loads to determine the effect of variables upon runoff and upon the suspended silt load.
(h) Reports are in progress.

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(962) (a) SILTING OF EXISTING RESERVOIRS.
(c) Hydrographic investigation to give data on silting of existing reservoirs.
(d) Hydrography Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine the quantity of silt deposited by the stream, the probable life of the reservoir, the effect of silt storage upon navigation channels and upon the silting of downstream reservoirs, and to obtain data for estimating the probable silting in comparable future developments.
(g) Selected ranges were probed and sounded for original and present bottom elevations, volumetric samples of deposited silt were collected and analyzed, and the quantity and distribution of silt were computed. Investigations have been made of Lake Davy Crockett on the Nolichucky River, Andrews Reservoir on the Hiwassee River, and Hales Bar and Wilson Reservoirs on the Tennessee River.
(h) Comprehensive silt report is in preparation.

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(963) (a) SILT TRAVERSES - TENNESSEE RIVER TRIBUTARIES.
(c) Hydrographic research.
(d) Hydrography Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine the relation of silt concentration to velocity distribution and whether any definite relation exists between the river discharge and the quantity of silt transported.
(g) Cross-sections have been selected at three tributary gaging-stations at which silt samples have been collected. A large number of silt samples will be taken at varying depths and points on the cross-section, at rising, falling, and crest stages. Velocity measurements will be taken at all the points at which samples are collected.
(h) Field work will be undertaken during high water season.

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U. S. WATERWAYS EXPERIMENT STATION.

(915) (a) MODEL STUDY OF THE MISSISSIPPI RIVER, HELENA, ARKANSAS, TO THE GULF OF MEXICO.
(b) The President, Mississippi River Commission, Vicksburg, Miss.
(c) Model study of flood-control plans.
(d) Experiments are conducted at the U. S. Waterways Experiment Station by personnel thereof under the general supervision of the Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) To test the effectiveness of various flood-control plans for improvement of the Lower Mississippi River.
(g) The model is of the fixed-bed type with scale ratios; horizontal dimensions, 1 to 2,000; vertical dimensions, 1 to 100. Reproduced in the model are: the main channel of the Mississippi River from Helena, Arkansas (mile 300 below Cairo, Illinois) to Donaldsonville, Louisiana, (mile 900 below Cairo, Illinois);

the entire Atchafalaya Basin as far south as the Gulf of Mexico; and the backwater areas of the Arkansas, White, Yazoo, Ouachita, and Red Rivers.

(h) Tests of certain channel improvements were completed. The model was revised to conform to a later survey and a study of flow lines for review of Mississippi River project is in progress.

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(473) (a) MODEL STUDY FOR CHANNEL IMPROVEMENT AT MARACAIBO OUTER BAR, VENEZUELA.

(b) Standard Shipping Company, New York, N. Y.

(c) Investigation of progressive westward movement of the outer bar with a view to probable future development.

(d) and (e) See (415).

(f) To study outer-bar action at the entrance of Lake Maracaibo, Venezuela.

(g) A model of the area in question was constructed to scales of 1 to 300, horizontal, and 1 to 50 vertical. Tides, waves, and other phenomena affecting flow in the area were reproduced in the model during the investigation.

(h) All testing has been completed.

(i) Results of the tests are incorporated in the final report, Technical Memorandum No. 106-1, titled, "Model Study of Channel Improvements at Outer Bar, Lake of Maracaibo, Venezuela."

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(480) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING IN GALVESTON HARBOR.

(b) The District Engineer, U. S. Engineer Office, Galveston, Texas.

(c) Study of proposed harbor improvements.

(d) and (e) See (415).

(f) The purposes of the study are:

1. To determine the sources of shoal material in Galveston Channel.
2. To determine the effects of any proposed improvement plan on the Galveston Channel, and corollary to that, the most feasible and economical plan.
3. To determine the effects of the improvement plans on the other ship channels (Texas City Channel, Houston Ship Channel, and Intracoastal Canal) in lower Galveston Bay.

(g) The model will include the area bounded by the Gulf of Mexico, Hanna's Reef in the East Bay, Redfish Reef in Galveston Bay, and Karankawa Reef in West Bay. Scale ratios are: horizontal dimensions, 1 to 800, vertical dimensions, 1 to 80. An area approximately 188 ft by 150 ft is covered by the model. Fixed-bed construction is employed in the model, and fine gilsonite powder is used for simulation of shoal material. Natural tides are reproduced by the action of four automatic tide gates of the type already in successful operation at the Experiment Station. To supplement tidal currents, wave action is reproduced in the model by the action of five wave machines.

(h) Tests were made of a proposed bridge acro s Bolivar Roads; base tests of silt and clear-water were made; and ten proposed plans for improvement were investigated. All clear-water tests of plans were completed and the silt-path tests of the approved plans are in progress.

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(535) (a) MODEL STUDY OF THE CHAIN OF ROCKS REACH, MISSISSIPPI RIVER (MILE 203 TO MILE 193 ABOVE CAIRO, ILLINOIS, AND THE MISSOURI RIVER FROM MILE 8 TO THE MOUTH).
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) Model study of plans for channel improvement.
(d) and (e) See (415).
(f) To determine the relative effectiveness of several proposed plans for improving navigation conditions in the Chain of Rocks Reach.
(g) The model was of the movable-bed type, using crushed coal as bed material. Model scales were: horizontal dimensions, 1 to 600, vertical dimensions, 1 to 125.
(h) All testing has been completed.
(i) Results of the tests are incorporated in the final report, Technical Memorandum No. 104-1, titled, "Model Study of Plans for Channel Improvement in the Chain of Rocks Reach, Mississippi River."

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(643) (a) MODEL STUDY OF MANCHESTER ISLANDS REACH, OHIO RIVER (MILE 394.6 TO MILE 396.8 BELOW PITTSBURGH, PENNSYLVANIA).
(b) The District Engineer, U. S. Engineer Office, Cincinnati, Ohio.
(c) Study of proposed channel improvements.
(d) and (e) See (415).
(f) To study the feasibility of certain plans for channel improvement, and to determine the practicability and location of a new navigation channel.
(g) The model is of the movable-bed type with scale ratios: horizontal dimensions, 1 to 300; vertical dimensions, 1 to 80. The area reproduced in the model includes the section of the Ohio River from mile 392 to mile 400 below Pittsburgh, Pennsylvania, and the adjacent overbank area to an elevation above the high water of 1937. In this reach two islands divide the Ohio River into three channels, two of which are either too narrow or too shallow for navigation at normal stages. The third channel (on the Kentucky side of the river) is used for navigation at all except high river stages, but requires excessive dredging for maintenance.
(h) All testing has been completed; preparation of final report has been begun.

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(786) (a) DETERMINATION OF THE TOPMOST FLOW-LINE AND MEASUREMENT OF PRESSURE IN THE SUPPLEMENTARY DAM AT THE U.S. WATERWAYS EXPERIMENT STATION.
(b) The Soils Laboratory.
(c) Scientific research.
(d) and (e) See (415).
(f) To determine the variation in the position of the topmost flow-line in the structure, and to observe the distribution of pressure in the foundation with Goldbeck pressure cells.
(g) Biweekly observations of the wells are made to add to the general fund of knowledge concerning seepage through such structures. Semiannual observations of the Goldbeck pressure cells are made.
(h) The observations are being continued.

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(793) (a) MODEL STUDY, FLOOD CONTROL PROJECT, JOHNSTOWN, PENNSYLVANIA.
(b) The District Engineer, U. S. Engineer Office, Pittsburgh, Pa.
(c) Flood control study.
(d) and (e) See (415).
(f) To determine the most feasible plans for increasing the channel capacity of the Conemaugh and Little Conemaugh Rivers and of Stony Creek, at Johnstown, Pennsylvania.
(g) A large-scale model, having a horizontal scale of 1 to 200, and a vertical scale of 1 to 80, has been constructed for the study. The model was so constructed that the effects of bridge piers, curves, changes in section, roughness of wall and bed, etc., are represented in correct ratio. The model was adjusted to reproduce the hydrography of the floods of 1935-37.
(h) The regular schedule of tests, and additional tests requested by the District Engineer, have been completed; preparation of the final report is in progress.

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(794) (a) SOIL MECHANICS RESEARCH CENTER.
(b) The Engineer Department at Large.
(c) Soils research.
(d) and (e) See (415).
(f) The Soil Mechanics Research Center is an Engineer Department Institution established at the U. S. Waterways Experiment Station by authority of the Chief of Engineers. The Center exists to disseminate to the Department at Large, data and information on soil mechanics and, further, to conduct such studies in the field of soil mechanics as other offices may request.
(g) The Soils Research Center issues bulletins in which experimental works of general interest are described. However, the Center is chiefly concerned with direct correspondence on specific problems.

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(795) (a) HYDRAULIC RESEARCH CENTER.
(b) The Engineer Department at Large.
(c) Hydraulic research.
(d) and (e) See (415).
(f) The purpose of the Hydraulic Research Center is to assemble and analyze experimental data of importance to the Engineer Department, and to make these data available to all districts of the department.
(g) The Research Center issues bulletins, in which experimental works of general interest are described. However, the Center is chiefly concerned with direct correspondence on specific problems.

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(966) (a) MODEL STUDY OF PLANS FOR CHANNEL IMPROVEMENT, VICINITY OF BOSTON BAR, MISSISSIPPI RIVER (MILE 2 TO MILE 13 ABOVE CAIRO, ILLINOIS).
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) Model study of proposed improvement plans.
(d) and (e) See (415).
(f) To test the feasibility of several proposed plans for channel improvement in the Boston Bar reach.
(g) The model was of the movable-bed type with scale ratios: horizontal dimensions, 1 to 600; vertical dimensions, 1 to 100. Reproduced was that reach of the Mississippi River between miles 16.3 above and 4.0 below Cairo, Illinois, together with adjacent overbank area extending to the levee on each bank. Within this reach (vicinity of Boston Bar) navigation had been difficult during low stages following the annual high-water period. The problem to be solved was the determination of the best system of regulating works which would provide a stable channel of project dimensions over Boston Bar crossing in its present alignment, or to devise a system of works which would realign the channel in a more favorable position.
(h) All testing has been completed; preparation of final report is in progress.

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(967) (a) MODEL STUDY OF SEEPAGE THROUGH LEVEE FOUNDATIONS, MEMPHIS DISTRICT.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tenn.
(c) Model study of seepage through levees.
(d) and (e) See (415).
(f) To obtain information concerning the relief of excess hydrostatic pressure at the landside of levees constructed on foundations consisting of an impervious surface stratum overlying pervious strata.
(g) The model on which this series of tests was conducted was constructed of loess and sand, placed to properly represent the areas of pervious and impervious strata. Various types of drainage systems were investigated during the course of the tests.

(h) All testing has been completed.
(i) Results of these tests are presented in Technical Memorandum No. 151-1, titled, "The Efficacy of Systems of Drainage Wells for the Relief of Subsurface Hydrostatic Pressure."

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(968) (a) MODEL STUDY OF SPILLWAY FOR GREAT SALT PLAINS DAM.
(b) The District Engineer, U. S. Engineer Office, Little Rock, Ark.
(c) Model study of spillway performance.
(d) and (e) See (415).
(f) To check the hydraulic characteristics of the spillway and outlet works as designed for Great Salt Plains Dam, and to correct any undesirable conditions which may be found to exist.
(g) The model was constructed to a scale of 1 to 36. Spillway was constructed of concrete, pyralin, and treated wood. A movable sand bed was provided below the spillway for qualitative study of erosion, etc.
(h) All testing has been completed.
(i) Results of the tests are presented in Technical Memorandum No. 148-1, titled, "Model Study of the Spillway for the Great Salt Plains Dam."

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(969) (a) MODEL STUDY OF WAVE FORCE AGAINST BREAKWATERS.
(b) The Division Engineer, Great Lakes Division, Cleveland, Ohio.
(c) Model study of distribution and intensity of wave forces.
(d) and (e) See (415).
(f) The purpose of the study is to develop a vertical pressure curve showing the pressures developed by waves striking against breakwaters. This vertical pressure curve would be used as a basis for design of breakwaters. As proposed for the model study, four variables would be investigated on the model and the resulting vertical pressure curves developed. These four variables are:
1. Heights and lengths of waves.
2. Depth of water and slope of bottom.
3. Shape of breakwater.
4. Angle of impingement of waves.
(g) The investigation is to be conducted in a wave tank, approximately 40 ft by 20 ft, in a temperature-controlled room. The tank will be equipped with a 6 ft by 3 ft viewing window in side at breakwater. A plunger-type wave machine, capable of producing a 1-ft wave will be used. Water -pressures will be measured by a bank of specially developed pressure cells and recorded simultaneously with wave heights on a seven-element oscillograph. Wave heights will be determined with a wave-height measuring device now in the process of development at the Experiment Station. Additional data will be recorded photographically.
(h) Design of the wave tank, wave machine, and appurtenances; and clearing of the site for the tank, have been completed. An improved wave-height measuring device has been designed, tested and found satisfactory. Construction of tank is in progress.

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(970) (a) SECOND SERIES, MODEL STUDY OF PLANS FOR ELIMINATION OF SHOALING IN THE DELAWARE RIVER ENTRANCE TO THE CHESAPEAKE AND DELAWARE CANAL.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of channel improvement plans.
(d) and (e) See (415).
(f) The purpose of the series of tests is:
1. To determine the effectiveness of the existing jetties under present conditions, with the enlarged canal.
2. To devise a plan for modification of the existing jetties in the event that they do not function properly under the conditions (1.) above.
3. To determine the relative shoaling in the Delaware River Ship Canal under existing and proposed jetty conditions.
(g) The model is of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 800; vertical, 1 to 80. Included are the Delaware River from New Castle, Delaware, to Artificial Island, and the Chesapeake and Delaware Canal from Reedy Point to Biddles Point. The Chesapeake and Delaware Canal connects the Delaware River with Chesapeake Bay. Tides and tidal currents are accurately reproduced on the model by means of three automatic tide gates: one at Artificial Island, one at New Castle, and one in the canal at Biddles Point. The range of tide in the Delaware River is approximately 5.5 ft, and in Chesapeake Bay about 2.5 ft, the former preceding the latter by about 10 hours. Unusual currents in the canal, brought about by such relations, cause large quantities of silt to be carried into the canal from the Delaware River and deposited near the mouth of the Delaware River entrance. As a result, extensive dredging has been necessary to maintain project dimensions in the canal.
(h) Tests made on a movable-bed model showed that this type of model was not suitable for the problem involved. Verification of the fixed-bed silt-injection type model, base tests, and all scheduled tests of improvement plans have been completed.

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(971) (a) MISSISSIPPI RIVER NAVIGATION STUDY.
(b) The President, Mississippi River Commission, Vicksburg, Miss.
(c) Model study of low-water flow conditions.
(d) and (e) See (415).
(f) The purpose of the investigation is to study low-water phenomena associated with the Mississippi River from Cape Girardeau (mile 52 above Cairo, Ill.) to Cottonwood Point (mile 125 below Cairo, Ill.), and with the Ohio River from Dam No. 53 to the mouth.
(g) The model is of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 1,000, vertical, 1 to 100. Channels of the Mississippi River from Cape Girardeau, Missouri, to Cottonwood Point, Missouri, and of the Ohio River from Dam No. 53 to the mouth, are reproduced. The model was designed and constructed to study channel flows between extreme low-water and bankfull stages.
(h) Model verification was completed and several series of tests were conducted to determine the effects of improvements in the channel. Tests of other improvement plans are in progress.

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(972) (a) MODEL STUDY OF SPILLWAY FOR THE NEW LOCK AND DAM NO. 1, ST. LUCIE CANAL.
(b) The District Engineer, U. S. Engineer Office, Jacksonville, Florida.
(c) Model study of spillway performance.
(d) and (e) See (415).
(f) The purposes of the model study were:
1. The determination of the relative effectiveness of the three proposed spillway designs, or if none of these prove adequate, the development of suitable design.
2. The calibration of the Taintor gates and the preparation of a set of discharge curves.
3. The determination of safe discharge quantities corresponding to the various tailwater stages with the view to the formulation of an operating schedule.
(g) 1 to 25 scale model included the spillway proper (sill, piers, and seven Taintor gates); the existing dredge pass and lock; the new lock (without gates); and the St. Lucie Canal for distances of 415 ft above and 604 ft below the dam. The spillway is designed for a discharge of 20,000 cfs.
(h) All model tests are complete.
(i) The results of the tests are presented in Technical Memorandum No. 153-1, titled, "Model Study of the Spillway for New Lock and Dam No. 1, St. Lucie Canal, Florida."

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(973) (a) MODEL STUDY OF SEEPAGE THROUGH MISSISSIPPI RIVER LEVEES.
(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.
(c) Model study of methods for seepage control.
(d) and (e) See (415).
(f) To find the most economical location for an effective tile drainage system proposed for installation in existing levees and to observe the topmost seepage line.
(g) A small-scale model of a typical portion of the levee was used in this study. The model was constructed of sand so placed in a glass-paneled flume as to simulate approximately the conditions which obtain in the prototype.
(h) All model tests have been completed.
(i) Results of the tests are presented in Technical Memorandum No. 155-1, titled, "Model Study of Internal Drainage Systems in Pervious Levees."

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(976) (a) MODEL STUDY OF EAST RIVER, NEW YORK (SECOND SERIES).
(b) The District Engineer, U. S. Engineer Office, New York.
(c) Study of proposed channel improvements.
(d) and (e) See (415).
(f) To develop an efficient plan for improving current directions through Hell Gate which would be satisfactory to all interests concerned.

(g) The model was of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 480; vertical dimensions, 1 to 80; and velocities (theoretical, confirmed during verification), 1 to 8.94. Reproduced in the model were: the main channel of the East River from Whitehall to Clasons Point; Little Hell Gate; Bronx Kill; and the Harlem River to its junction with the Hudson River. Velocities, tides, and current directions were simulated by simultaneous operation of tide-control apparatus at Whitehall and Clasons Point on East River, and at Spuyten Duyvil on the Harlem River. Two principal areas (Hell Gate and Belmont Island vicinities) were subjected to tests under various channel conditions to develop the most satisfactory current alignments.
(h) All tests have been completed.
(i) Results of the tests are presented in Technical Memorandum No. 125-3, titled, "Model Study of Tidal Currents in East River, New York."

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(1137) (a) MODEL STUDY OF INTAKE AND CONDUIT, CONTROL STRUCTURES FOR DENISON DAM.
(b) The District Engineer, U. S. Engineer Office, Denison, Texas.
(c) Study of intake and conduit structures.
(d) and (e) See (415).
(f) To investigate hydraulic conditions through the control structures and through the flood-control conduits.
(g) 1 to 25 scale model reproduces one entire section of the control works including (1) intake passages to a pair of gates (each conduit is served by two gates), (2) the pair of gates, (3) transition below the gates, and (4) conduit below the transition. The entire model is constructed of transparent pyralin. Each flood-control conduit was designed for a capacity of 20,000 cfs with the pool at spillway crest elevation.
(h) All testing has been completed; preparation of final report is in progress.

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(1138) (a) MODEL STUDY OF STILLING BASIN, CONTROL STRUCTURES FOR DENISON DAM.
(b) The District Engineer, U. S. Engineer Office, Denison, Texas.
(c) Study of stilling basin action.
(d) and (e) See (415).
(f) To investigate hydraulic conditions within and below the stilling basin, and in the tailrace below the power plant.
(g) 1 to 36 scale model reproduces (1) outlet sections of the four power conduits and the four flood-control conduits, (2) tailrace below the power conduits, (3) stilling basin below the flood-control conduits, and (4) the exit channel to its confluence with the Red River. The eight conduits are to discharge uncontrolled during the diversion period; under such conditions they will have a combined capacity of 88,500 cfs with the pool at cofferdam elevation. The flood-control conduits will also have a capacity of 89,000 cfs with pool at spillway crest elevation. Elements of the stilling basin are diverging spray walls, baffle piers, and weirs. The model

study had two phases: investigation of performance of stilling basin under all conditions of operation for the flood-control conduits; and investigation of the action in the tailrace with the power conduits discharging freely under conditions of diversion.

(h) All testing has been completed; preparation of final report is in progress.

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(1139) (a) MODEL STUDY OF INTAKE STRUCTURE (PLAN A), FORT PECK DAM.
(b) The Division Engineer, Missouri River Division, Kansas City, Missouri.
(c) Study of intake structure.
(d) and (e) See (415).
(f) To investigate proposed modifications in the design of the present intake structures.
(g) 1 to 20 scale model includes a section of the reservoir area, one complete bay of intake structure together with adjoining half bays. Trash racks, intake chamber, transition section, and a portion of one tunnel, were reproduced in the complete bay.
(h) All testing has been completed; preparation of final report is in progress.

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(1140) (a) MODEL STUDY OF SPILLWAY FOR SANTEE RIVER DAM.
(b) The South Carolina Public Service Authority, Charleston, S.C.
(c) Model study to determine suitable spillway design.
(d) and (e) See (415).
(f) To develop the most advantageous design for the spillway with especial efforts directed toward a complete analysis of the elements of the spillway, whose functions are the dissipation of energy contained in flow from the spillway gates.
(g) 1 to 36 scale model reproduced a section of the spillway proper (consisting of six complete bays), 360 ft of the approach channel, and 900 ft of the exit channel. Three of the bays contained gang-operated gates, and three contained individually-operated gates (Taintor gates reproduced schematically). In the prototype, initial flows up to 50,000 cfs will be passed through six gang-operated gates; higher flows will be passed through the remaining 56 gates after the tailwater has been built up to the normal elevation corresponding to a discharge of 50,000 cfs.* Because of the large range in tailwater elevations a sloping apron has been provided to produce the optimum hydraulic jump performance.
(h) All scheduled tests have been completed; preparation of final report has been begun.

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*The spillway has been designed to discharge a flood flow of 800,000 cfs.

(1141) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING IN RICHMOND HARBOR, JAMES RIVER.
(b) The District Engineer, U. S. Engineer Office, Norfolk, Va.
(c) Model study of plans for the elimination of shoaling.
(d) and (e) See (415).
(f) To determine the effects of proposed works (1) in eliminating shoaling in Richmond Harbor, and (2) on flood heights through and above the reach in which the works are to be located.
(g) The model will be of the movable-bed type with scale ratios; horizontal dimensions, 1 to 72; vertical dimensions, 1 to 36. Richmond Harbor is located at the head of tide water in the James River. At Richmond the tidal range averages about 3.9 ft. Immediately above Richmond there is a reach containing rapids in which the river falls about 100 ft in 10 miles. This steep section of the river blocks the further progression upstream of the tidal wave. At the Richmond waterfront the river is almost twice as wide as in the reaches downstream, which have been contracted by groins. Deposition of material in the project channel near Richmond Harbor makes necessary a continuous dredging program.
(h) Design of model completed; construction approximately 75 per cent completed.

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(1142) (a) MODEL STUDY OF CHANNEL IMPROVEMENT, FLOOD CONTROL PROJECT, HORNELL, NEW YORK.
(b) The District Engineer, U. S. Engineer Office, Binghamton, N.Y.
(c) Model study of improvement plans for flood control.
(d) and (e) See (415).
(f) To supplement and verify hydraulic design computations for determination of final design plans for the improvement of Canisteo River, Canacadea Creek, and Chauncey Run, at Hornell, New York.
(g) 1 to 40 scale fixed-bed model includes 3,600 ft of Canacadea Creek, 10,800 ft of Canisteo River and 700 ft of Chauncey Run. Three drop structures and one trapezoidal weir fall within the reaches reproduced in the model. Canisteo Channel is designed to discharge 21,000 cfs; Canacadea Channel, 8,000 cfs; and Chauncey Channel, 3,300 cfs. The Canacadea Creek section of the model was operated for one month as a separate model.
(h) All scheduled tests have been completed; preparation of final report is in progress.

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(1143) (a) MODEL STUDY OF CHANNEL IMPROVEMENT, ABSECON INLET, ATLANTIC CITY, NEW JERSEY.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of proposed jetty designs.
(d) and (e) See (415).

(f) To determine the effects of several proposed jetty designs at the mouth of Absecon Inlet with special attention to their efficacy in maintaining a ship channel, and their probable effect on the beaches at Atlantic City.
(g) The model is of the movable-bed type (the movable-bed reach extends from Ventnor, New Jersey, to a point on Brigantine Beach 22,000 ft northeast of Absecon Inlet). Scale ratios: horizontal dimensions, 1 to 500; vertical dimensions, 1 to 100. Provisions are made for reproducing waves from any direction from south to east, tides of any type, and littoral drift either up or down the beach.
(h) Design and construction of the model and appurtenances (except the wave machine) have been completed. Hydraulic adjustment of the model is in progress.

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(1144) (a) MODEL STUDY OF TUNNEL NO. 1, FORT PECK DAM.
(b) The Division Engineer, Missouri River Division, Kansas City, Missouri.
(c) Model study of hydraulics of tunnel and Y-branches.
(d) and (e) See (1145).
(f) To investigate the surge phenomena in Tunnel No. 1 resulting from turbine gate operation, and to evaluate the effects of the main shaft upon these phenomena; and to determine the relative efficiencies of four types of Y-branches for the penstocks.
(g) 1 to 20 scale model, approximately 250 ft in length, includes the intake structures, emergency control shaft, main control shaft, Y-branch, penstocks, and surge chambers. Each penstock is fitted with a valve mechanically operated so as to reproduce turbine gate closure. Model is constructed of transparent 0.25-in. pyralin, which computations have indicated to be of requisite elasticity such that the velocity of pressure wave propagation is brought into approximate scale ratio. Instantaneous measurements of pressure waves and surges at critical points are accomplished by means of pressure cells and electrodes in circuit with a seven-element oscillograph. Tests are conducted for a discharge of 6,800 cfs.
(h) Design and construction of model have been completed. Tests of Y-branches have been completed and model has been prepared for the testing of surge phenomena.

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(1145) (a) MODEL STUDY OF STRUCTURES FOR FUTURE POWER DEVELOPMENT, FRANKLIN FALLS DAM.
(b) The District Engineer, U. S. Engineer Office, Boston, Mass.
(c) Model study to investigate the adequacy of design of elements of the powerhouse and appurtenant structures.
(d) and (e) See (1145).
(f) To investigate the adequacy of the design of powerhouse forebay and appurtenant structures; and to develop improvements therein, if necessary, with respect to the following requirements: (1) efficient functioning for

power development; (2) safe passage of full tunnel flow with intake gates in operation; and (3) that there be no interference with the proper action of the stilling basin for flood control outlets by the tailrace discharge of the proposed power development.

(g) 1 to 25 scale model includes the tunnel, forebay, forebay-weir, penstocks, tailrace, two short portions of the flood-control conduits, flood-control outlet stilling basin and 400 ft of the exit channel. The maximum discharge required for the turbines is 3,200 cfs. However, the 25-ft-diam. tunnel, forebay and forebay-weir must be able to pass safely a discharge of approximately 20,000 cfs.

(h) Design and construction of model have been completed. Testing is in progress.

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(1146) (a) MODEL STUDY OF EFFECTS OF DIKES ON CHANNEL CAPACITIES, MISSOURI RIVER.

(b) The District Engineer, U. S. Engineer Office, Omaha, Nebraska.

(c) Model study of contraction works in an alluvial river.

(d) and (e) See (415).

(f) To determine the effects of contraction works in the form of dikes on the channel capacity of an alluvial river.

(g) Two models were used in this study: (1) the Boston Bar model of movable-bed type with scale ratios: horizontal dimensions, 1 to 600, vertical dimensions, 1 to 100, reproducing that reach of the middle Mississippi River between miles 2.0 and 29.8 above Cairo, Illinois. (2) The Swiftsure Towhead model of movable-bed type with scale ratios: horizontal dimensions, 1 to 600, vertical dimensions, 1 to 120, reproducing that reach of the middle Mississippi River between miles 52.1 and 66.3 above Cairo, Illinois. Tests were made on the models with contracted and uncontracted channels. Resulting water-surface elevations of the stages applied to the stable beds were compared.

(h) All tests have been completed. Final report was not published; inquiries should be addressed to the District Engineer, Omaha, Nebraska.

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(1147) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING, VICINITY OF THE HEAD OF PASSES, MISSISSIPPI RIVER.

(b) The District Engineer, U. S. Engineer Office, First New Orleans District, New Orleans, Louisiana.

(c) Model study of plans for channel improvement.

(d) and (e) See (415).

(f) To study and develop plans for the improvement and maintenance of the deep-water channel from Head of Passes to the Gulf of Mexico through Southwest Pass.

(g) The model is of the movable-bed type with scale ratios: horizontal dimensions, 1 to 500; vertical dimensions, 1 to 150. Reproduced are 7 miles of the Mississippi River above the Head of Passes; all of South and Southwest Passes; the upper two miles of Pass a l'Outre; Cubits Gap; and all

dikes and jetties in the prototype in 1937. Cubits Gap is controlled to discharge a fixed percentage of the flow, while the other three passes are controlled by water-surface elevations at their lower ends.

(h) Design and construction of the model have been completed and hydraulic adjustment begun.

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(1148) (a) MODEL STUDY OF BREAKWATER LOCATIONS IN SAN JUAN HARBOR, PUERTO RICO.

(b) The District Engineer, U. S. Engineer Office, Puerto Rico District, in conjunction with the U. S. Navy Department.

(c) Model study of breakwater locations.

(d) and (e) See (415).

(f) To establish the location of breakwaters in San Juan Harbor to provide protective works for a hydroplane base.

(g) The model will be of the fixed-bed type with scale ratios (model-to-prototype) of 1 to 100, and will reproduce that part of San Juan Harbor seaward of a line from Catano Point to Yaboa Shoal together with an area extending seaward approximately 3,800 ft to the north of Morro Point. The model limits will extend from 1,700 ft east of Morro Point to 1,000 ft west of Palo Seco Point.

(h) Design of model completed; construction in progress.

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(1149) (a) MODEL STUDY OF SPILLWAY AND STILLING BASIN, CADDOA DAM, ARKANSAS RIVER.

(b) The District Engineer, U. S. Engineer Office, Caddoa, Colorado.

(c) Study of spillway and stilling basin action.

(d) and (e) See (415).

(f) To investigate the hydraulic performance of the spillway and stilling basin, to improve flow characteristics, and to determine possible economies in the design.

(g) The proposed Caddoa dam will be an earth structure with an overflow spillway located within the main section of the dam. Flows will be regulated by means of conduits through the spillway section, the outflow being limited to 10,000 cfs. For extreme floods sixteen Taintor gates surmounting the spillway crest will be used. The spillway is designed to pass a flood of 650,000 cfs under a head of 30 ft. The model will be constructed to the scale ratio of 1 to 55 and will reproduce a longitudinal section of the spillway embracing eight gate bays, together with 500 ft of the approach channel and 1,100 ft of the exit channel. The spillway will be constructed of concrete, the crest-gate piers of treated wood, the Taintor gates of sheetmetal, and the conduits of sheetmetal and of pyralin (one conduit). A movable sand bed will be provided below the spillway for qualitative study of erosion, etc.

(h) Design and construction of the model are in progress.

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(1150) (a) HYDROLOGICAL RESEARCH PROJECT.
(b) Office, Chief of Engineers, Washington, D. C.
(c) Scientific investigation of general hydrological phenomena.
(d) and (e) See (415).
(f) The principal objectives are to make a detailed study of rainfall and runoff phenomena with a view to increasing our knowledge of the hydrological characteristics of any drainage basin including the unit-graph theory and the determination of the infiltration capacity of the soil under different conditions of rainfall and during different seasons of the year.
(g) This study of a small watershed tributary to the artificial lake on the reservation of the U. S. Waterways Experiment Station will include the following investigations:
1. Measurement of rainfall at 28 stations throughout the watershed. Five recording gages and 23 non-recording gages are planned.
2. Measurement of inflow into the lake; outflow from the lake; wave heights on the lake; and evaporation, both from the land areas and from the lake.
3. Investigation of ground-water levels at strategic locations; and miscellaneous recordings, such as temperature, humidity, and wind velocity.
(h) Preliminary design of necessary equipment and survey of the watershed are in progress.

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NATIONAL BUREAU OF STANDARDS. NATIONAL HYDRAULIC LABORATORY.

(42) (a) INVESTIGATION OF THE PHYSICS OF PLUMBING SYSTEMS.
(b) National Bureau of Standards.
(c) General research.
(d) R. B. Hunter, E. Hermansen, L. C. Olsen, F. B. Leonard.
(e) The Director, National Bureau of Standards.
(f) To obtain data on which to base logical estimates of the capacities of vertical and sloping drain pipes in plumbing systems, and to make a study of safety requirements with special reference to back-siphonage and venting.
(g) It is proposed to collect and correlate as far as possible existing data on these subjects and to make such supplementary experiments as may be necessary to meet the purpose of the investigation.
(h) A paper, "Methods of Estimating Loads in Plumbing Systems," has been prepared for publication.
(i) This project is being carried on in conjunction with Project 797, also reported in this Bulletin.

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(43) (a) INVESTIGATION OF PIPE BENDS.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, G. H. Keulegan, E. F. Husten.
(e) The Director, National Bureau of Standards.

(f) To obtain the general laws of head loss in pipe bends; to correlate, insofar as possible, all available results of previous investigations; to obtain practicable formulas for use by engineers; and to extend the results to include flow of other fluids, such as oils, steam, etc.
(g) Laboratory tests are planned on smooth and rough pipe bends of various diameters and central angles; and on miter bends and cast fittings.
(h) Experiments on 1-inch smooth pipe coils of one to ten or twelve turns and radii up to about four feet are under way.

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(171) (a) INVESTIGATION OF THE PRESSURE VARIATIONS ON THE UPSTREAM AND DOWNSTREAM SIDES OF AN ORIFICE PLATE OR FLOW NOZZLE.
(b) National Bureau of Standards.
(c) Scientific data.
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To obtain more complete data than are now at hand on the variations of pressure in the vicinity of an orifice plate or flow nozzle, which will assist in better correlation of orifice coefficient data, and the selection of suitable pressure tap locations for use with flow nozzles.
(g) Water from a constant-head tank will be discharged through the orifice section of the line into either a weighing or calibrated volumetric tank. Simultaneous readings will be made of the pressure at 48 pressure openings extending from the orifice plate face to about 4 pipe diameters upstream and 10 pipe diameters downstream. It is planned to vary the ratio of orifice to pipe diameter from about 0.05 to over 0.8, and to vary the Reynolds number over at least 1 to 10 range for each orifice.
(h) Work on nozzles practically completed. Similar tests have yet to be made with square-edged thin-plate orifices. Project temporarily inactive.
(i) A tentative report covering tests with nozzles was given in "Some results from research on flow nozzles", Trans. A.S.M.E., Vol. 60, No. 5, April 1938, page 385.

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(342) (a) STUDIES OF ARTIFICIAL CONTROLS FOR STREAM-FLOW MEASUREMENTS.
(b) U. S. Geological Survey, Water Resources Branch.
(c) Cooperative project with U. S. Geological Survey for comparative performance tests and general scientific research.
(d) M. A. Mason and H. N. Eaton (National Bureau of Standards), C. H. Pierce (Geological Survey).
(e) The Director, National Bureau of Standards.
(f) To study the relative merits of the various designs of several district offices of the Survey, with a view to standardizing on a few selected types.

(h) A report, entitled, "Investigation of Artificial Stream Control Structures", was furnished the U. S. Geological Survey on May 1, 1939. A few copies are available at the National Bureau of Standards.

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(384) (a) TESTS OF SPILLWAY FLASHBOARD PINS.
(b) U. S. Forest Service.
(c) Cooperative project with the U. S. Forest Service for testing field designs under simulated field conditions in the laboratory.
(d) C. A. Wright (formerly with National Bureau of Standards), C. A. Betts (U. S. Forest Service).
(e) The Director, National Bureau of Standards.
(h) A paper entitled, "Flashboard Pins", by C. A. Wright and C. A. Betts was published in the Proceedings American Society of Civil Engineers, Vol. 65, No. 5, May 1939, pages 771-803.

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(496) (a) DETERMINATION OF DISCHARGE COEFFICIENTS OF FLOW NOZZLES. Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters.
(b) Factors for use in commercial measurement of fluids.
(c) Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters, with cooperation of the National Bureau of Standards, University of California, Ohio State University, University of Oklahoma, Cornell University, Massachusetts Institute of Technology.
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To determine discharge coefficients for "long-radius" flow nozzles; to determine the most satisfactory location for pressure holes; to check, compare, and correlate American and European designs and practices.
(g) Tests have been made on nozzles in 2, 3, 4, 8, and 16-inch pipes. Fluids used have been oil, water, steam and air. Some nozzles have been tested with 2 or 3 of these fluids.
(h) Test program 98% completed. Tests on some 8" pipe nozzles to be made.
(i) Present plan is to issue a complete report on this project at annual meeting of A.S.M.E., in December 1940.

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(563) (a) AGING TESTS ON PIPES.
(b) U. S. Treasury Department.
(c) Cooperative project with the Division of Metallurgy, National Bureau of Standards.
(d) K. H. Beij, B. F. Husten.
(e) The Director, National Bureau of Standards.
(f) To determine the effects of long-continued service on the hydraulic friction of pipes.

(g) Specimens of 1-1/4 inch pipes of nine different materials have been installed in a cold-water line in constant service, and specimens of 3/4-inch pipes of seven different materials have likewise been installed in hot-water service lines at the National Bureau of Standards. It is planned to determine the hydraulic resistance coefficients of these specimens at intervals over a period of 20 years.

(h) Preliminary tests (before aging) were made in 1936; observation tests were made in 1937 and 1938. It was decided to omit the observation tests scheduled for August, 1939. The next tests will be made in July or August 1940.

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(564) (a) DENSITY CURRENTS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan, G. W. Patterson, H. M. Eaton.
(e) The Director, National Bureau of Standards.
(f) To determine the laws of currents in miscible stratified fluids.
(h) A paper has been prepared for publication in the National Bureau of Standards Journal of Research. Further tests have been made using sugar solutions for both layers of liquid in the testing channels described in earlier issues of this Bulletin.

The theory of the laminar layers at the interface of two liquids which enables the thickness of the layer and the velocity distribution in it to be computed has been developed. This will be prepared for publication shortly.

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(616) (a) FLOW IN OPEN CHANNELS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan, G. W. Patterson.
(e) The Director, National Bureau of Standards.
(f) To investigate the phenomena of open channel flow in the light of modern concepts of turbulent flow. This will involve a study of the dependence of the hydraulic friction factor on the cross-section of the channel and on the roughness of its surfaces, the apparent friction of the free surface, and the depression of the filament of maximum velocity.
(h) Some time has been given to the study of the laws of similarity for flow in open channels. A rigorous derivation of the equation of mean flow in open channels taking account of velocity distribution has been completed and will be prepared for publication in the near future.

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(797) (a) PLUMBING MATERIALS AND EQUIPMENT AS RELATED TO LOW-COST HOUSING.
(b) National Bureau of Standards.
(c) Part of a coordinated program of research on low-cost housing.
(d) R. B. Hunter, E. Hermansen, L. O. Olsen, F. B. Leonard.
(e) Dr. H. L. Dryden, Coordinator of Program, National Bureau of Standards.
(f) To assemble the data necessary for developing uniform standards and specifications for materials and construction for plumbing installations in low-cost housing construction under Federal control.
(g) A review and study of existing standards as they apply to the field of low-cost housing will be made, together with an experimental study of plumbing piping layouts (water supply, drain, and vent pipes) relative to minimum requirements for the efficient functioning of the system.
(h) Experimental work on this project has been completed, and the results are being prepared for publication in the National Bureau of Standards Building Materials and Structures Series. A paper, "Methods of Estimating Loads in Plumbing Systems", has been completed and will be published shortly. Other papers dealing with capacities of building water-distributing systems, capacities of building drainage systems, and the theory and practice of venting in plumbing systems are in progress.

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(977) (a) MATHEMATICAL THEORY OF FLOOD WAVES.
(b) Cooperative project with the U. S. Weather Bureau.
(c) General research.
(d) G. H. Keulegan, and G. W. Patterson for the National Bureau of Standards. R. T. Zoch for the U. S. Weather Bureau.
(e) The Director, National Bureau of Standards.
(f) To review the European and American literature on the mathematical theory of waves having direct application to the phenomena of flood waves.
(g) The results of this review will be coordinated and presented in a series of papers dealing individually with the following subjects: (1) The irrotational flow theory of translation waves, (2) Approximate solutions of wave phenomena involving the friction of the bed, (3) The quasi-permanent régime of rivers, and (4) Recent advances in the unrestricted theory of waves.
(h) The first paper in the series, "The mathematical theory of irrotational translation waves", by G. H. Keulegan and G. W. Patterson, will be published in the National Bureau of Standards Journal of Research for January 1940 as Research Paper RP 1272. About two months later reprints will be available for purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of 10 cents per copy (Stamps not accepted). See abstract in this Bulletin.

Considerable progress has been made on the preparation of the second and third papers in the series. The second paper will deal with the effect of friction on wave phenomena, the third with the quasi-permanent régime of rivers and the forecasting of floods.

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(978) (a) MODEL STUDIES, INDIAN ROCK DAM.
(b) U. S. Engineer Office, Baltimore, Md., Col. Wm. A. Johnson, District Engineer.
(c) Study of performance of side-channel spillway, tunnel intake, and outlet works for spillway channel and tunnel.
(d) K. H. Deij for the National Bureau of Standards; F. W. Edwards and C. L. Winslow for the U. S. Engineer Office. M. A. Mason, L. L. DeFabritis, C. W. Elliot, J. W. Boyd, B. F. Husten, F. B. Leonard.
(e) The District Engineer, U. S. Engineer Office, Baltimore, Md.
(f) To check rating curve of spillway weir and capacity of spillway channel; to determine effect of bend in spillway channel; to study flow at conservation dam and intake of tunnel; to study design of outlet works of spillway channel and tunnel; and to study scour in lower river valley.
(g) Two models were built and tested. Model No. 1, on a scale of 1 to 60, included the complete spillway weir and channel, the outlet works, a portion of the reservoir, and a considerable section of the lower river valley. Model No. 2, on a scale of 1 to 32.4, included the tunnel with intake and outlet works, a conservation dam, and a small section of the downstream river bed.
(h) All tests have been completed. A condensed report summarizing the results of the tests and giving recommendations based thereon was submitted to the District Engineer. It is expected that a final report, giving data and conclusions in detail will be submitted in January, 1940.

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(979) (a) STUDY OF DREDGE SUCTION BOOSTER.
(b) The District Engineer, U. S. Engineer Office, Washington, D. C.
(c) Tests of a pipe-line dredge-suction line with and without an axial-flow impeller at the suction-line entrance.
(d) L. L. DeFabritis for the National Bureau of Standards; Major D. L. Newman for the U. S. Engineer Office. L. O. Olsen, B. F. Husten, H. Hessing, G. Werner, C. W. Elliot.
(e) The District Engineer, U. S. Engineer Office, Washington, D. C.
(f) To compare the concentration of solids in a model pipe-line dredge-suction line with and without a booster pump at the suction entrance, for different velocities in the line and dredging from a sand bed that moves relatively to the line, with the view to determining the effect of the boester on the concentration of solids.

(g) A sloping, 3-inch diameter suction line with an enlargement to a 4-inch diameter entrance remained fixed relative to the submerged sand tank. The 3-inch main pump was set up in three positions attached to the sloping suction line by: (1) a short horizontal pipe; (2) a long horizontal pipe; (3) a long pipe rising at 45 degrees. When worn, the 4-inch diameter axial-flow impeller was replaced by a single-stage, mixed-flow pump assembly, 4-inch nominal diameter, complete with suction and discharge bowls and guide vanes.
(h) Authorized tests have been completed. A report to the District Engineer is being prepared.

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(980) (a) CALIBRATION OF 36-INCH VENTURI METER.
(b) National Bureau of Standards.
(c) Determination of the characteristics of a 36 x 18 inch Venturi meter.
(d) M. A. Mason.
(e) The Director, National Bureau of Standards.
(f) To determine the characteristics of a venturi meter intended for service as a secondary standard of measurement.
(g) An attempt will be made to employ for calibration purposes, several methods of water measurement, with emphasis placed on the calibration by pitot tube traverses of the venturi throat. Results of the calibration will be available for studies of the similitude between venturi meters.
(h) A study of available literature has been completed, and pressure connections and manometers installed. Orifice meters for use in the calibration have been designed and are being constructed.

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(981) (a) INSTALLATION REQUIREMENTS FOR HEAD METERS SUCH AS ORIFICES, FLOW NOZZLES, ETC.
(b) Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters with the National Bureau of Standards and Washington Gas Light Co.
(c) Laboratory investigation simulating certain possible plant conditions.
(d) A.S.M.E. Fluid Meters Committee, National Bureau of Standards, Washington Gas Light Co. H. S. Bean, F. C. Morey, E. C'Connor (at the National Bureau of Standards).
(e) H. S. Bean, National Bureau of Standards.
(f) To verify and extend previous tests to determine the minimum necessary conditions for installation of head meters, particularly orifices and nozzles.
(g) Using orifices and nozzles in 4-inch pipe to determine the effects of bends, valves, etc., on the inlet side upon the indications of the meter. Tests will be made with both gas and water.

(h) Tests using air at low pressures have been completed on more than 6 combinations each with 4 to 6 distances between meter and fitting. Check tests are to be made with water.

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(982) (a) FUNCTIONAL CHARACTERISTICS OF PLUMBING FIXTURES AND FITTINGS.
(b) Cooperative project with Plumbing Fixtures Manufacturers Associations.
(c) General research on plumbing fixtures.
(d) Gene E. Golden.
(e) Gene E. Golden, National Bureau of Standards.
(f) To determine the functional characteristics of plumbing fixtures with a view toward developing functional and test specifications.
(g) Recording of the variable phenomena that occur in plumbing fixtures is being done by photographic and mechanical means in order to allow more detailed analysis.
(h) Studies of water closets and the supply and drainage of other fixtures are under way.
(i) Bulletin BMS88, "Backflow Prevention in Over-Rim Water Supplies", a paper on safe air-gaps, has been published by the National Bureau of Standards.

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(1151) (a) SALT-DILUTION METHOD OF WATER MEASUREMENT.
(b) National Bureau of Standards.
(c) Flow-measurement research.
(d) M. A. Mason.
(e) The Director, National Bureau of Standards.
(f) To define the possibilities and limitations of the salt-dilution and related methods for the measurement of water in open or closed channels.
(g) Studies will be made of the mixing process to develop a criterion defining the applicability of the method. Electro-chemical methods of analyzing the solutions will be investigated. Laboratory and field tests will be used to check theoretical development.
(h) Preliminary studies of electrodes for use in investigating the mixing process are in progress.

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(1152) (a) TRANSPORTATION OF SAND IN PIPES.
(b) Chief of Engineers, U. S. Army, Washington, D. C.
(c) Research.
(d) L. L. DeFabritis, for the National Bureau of Standards; Col. E. J. Dent (retired), for the U. S. Engineer Office. L. C. Olsen, B. F. Husten, H. Hessing, C. W. Elliot.
(e) Chief of Engineers, U. S. Army, Washington, D. C.
(f) To determine the general laws of head loss in pipes carrying sand and water mixtures.
(g) Tests are planned on standard, black, steel pipes having nominal diameters of 2, 3, 4 and 6 inches. Relatively

complete study of the 4-inch size will include measurement of the head loss for a range of velocities transporting sand of a carefully controlled grain size in concentrations ranging from zero to the maximum possible, repeating the procedure with each of a sufficient series of grain size and arbitrary mixtures of grain sizes. Similar studies, but less intensive, will be made on the 2- and 3-inch pipe sizes over a corresponding range of conditions and on the 6-inch pipe size over a narrower range of velocities and concentrations.

(h) Equipment is being purchased and laboratory space is being cleared for the construction of the test apparatus.

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U. S. BEACH EROSION BOARD WAVE TANK.

(1153) (a) STUDY OF OSCILLATORY WAVES.
(b) Laboratory research.
(c) Laboratory project.
(d) Lt. W. C. Hall, C. E.
(e) Major A. C. Lieber, jr., C. E.
(f) To study the characteristics of oscillatory waves. To compare the theoretical relationships of height, length, period, velocity, orbital motion, and mass transfer with values obtained in a wave tank.
(g) Waves are generated by a vertical plunger in a wave tank with horizontal fixed bottom. Wave energy is dissipated on a wave absorber at the opposite end. Characteristics are measured under conditions of steady oscillation.
(h) Runs in progress.

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(1154) (a) DEVELOPMENT OF WAVE PROFILER.
(b) Laboratory research.
(c) Laboratory project.
(d) Dr. W. A. Laning, Jr. and David H. Mitchell.
(e) Major A. C. Lieber, jr., C. E.
(f) To develop by the use of three oscillograph elements and recording accessories a reliable method of simultaneously determining all wave characteristics, including profile and direction for use in the wave tank or in the ocean.
(g) Determination of a straight-line variation of band with wave height for single elements in the wave tank.
(h) Experiment in progress.

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(1155) (a) A MODEL STUDY OF THE EFFECT OF SUBMERGED BREAKWATERS IN WAVE ACTION.
(b) Laboratory research.
(c) Laboratory project.
(d) Lt. W. C. Hall, C. E.

(e) Major A. C. Lieber, jr., C. E.
(f) To study the effect of submerged structures on wave characteristics.
(g) A non-dimensional analysis of the effect in two dimensions of structures for varied wave action and depth of water.
(h) Experiment completed and draft of report prepared for triangular, trapezoidal, and rectangular structures.
(f) Data being obtained for study of constructed and proposed submerged breakwaters and jetties.

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U. S. SOIL CONSERVATION SERVICE.

SOIL CONSERVATION SERVICE AT THE NATIONAL BUREAU OF STANDARDS.

(258) (a) STUDY OF DIVISORS FOR SOIL EROSION INVESTIGATIONS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, Fred W. Blaisdell, H. L. Cook.
(e) Chief, Soil Conservation Service. (Attention H. L. Cook).
(f) Calibration of divisors now in use; study of relative accuracy of various types; development of new divisors.
(g) Calibrations are being made of divisors as they are developed, both with clear and with muddy water, to determine their effectiveness in splitting off a fixed percentage of the water and soil passing.
(h) Of the several types tested to date, the Geib multislot divisor has proved to be the best. It has been developed for use on areas ranging from one-hundredth to one-half acre.
(i) There is still a great need for devices suitable for larger areas.

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(341) (a) STUDY OF MEASURING FLUMES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, Fred W. Blaisdell, H. L. Cook.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) The development and calibration of more suitable devices for the measurements of rates of runoff from experimental areas.
(g) The study involves the design, construction, and calibration of new types, particularly for maximum flows ranging between twenty-five and one-thousand cubic feet per second. Calibration test of models of some existing controls will also be made.
(h) After the construction and trial of many types of flumes, the H and HS designs have been selected for use for flows up to thirty cubic feet per second. Plans and calibration tables have been prepared. Ratings by means of tests of models were obtained for devices installed at the Blackland Experimental Watershed, Waco, Texas. Each installation consists of a Parshall flume and a shallow Columbus notch. The flumes vary in width from six to fifteen feet.

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(497) (a) METHODS OF SAMPLING AND ANALYZING SOIL-WATER MIXTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, E. P. Deatrick, J. O. Laws, S. R. Kline, H. L. Cook.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) Determination of the best methods of sampling and analysis from the standpoints of accuracy and efficiency.
(g) The work is confined almost entirely to studies of the methods of sampling retained volumes of runoff and the subsequent analysis of the samples taken.
(h) Tests have been made of a number of sample splitters and of several methods of sampling volumes of mixtures of soil and water. The variables in the sampling tests have been: kind of soil, depth and volume of mixture, and concentration. The submersion, weight-volume, and evaporation methods of analysis have been studied.

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(707) (a) DEVELOPMENT OF ARTIFICIAL RAINFALL APPARATUS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, V. D. Young, J. O. Laws, H. L. Cook.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) Development and study of the methods of use of devices for the production of artificial rain of controlled intensity and spray energy.
(g) The spray characteristics of commercial and laboratory-developed nozzles have been studied. Complete plans for the construction of sprinkler units for field use are being prepared.
(h) Four of the six devices for sprinkling experimental plots are being or have been used in field investigations of soil infiltration rates, erosion and other run-off phenomena. Devices employing the type F nozzle are now coming into considerable use.

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(936) (a) STUDY OF THE EFFECT OF THE CHARACTER OF RAIN ON INFILTRATION AND WATER EROSION.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Research in the mechanics of erosion.
(d) D. A. Parsons, J. O. Laws, H. L. Cook.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To investigate the roles of the size, velocity and energy of raindrops in the water erosion process.
(g) Studies are being made of the velocity and energy of water drops of various sizes, of the effect of rain energy on the erosion from elementary areas of soil and of the characteristics of natural raindrops.
(h) A study of the velocity of water-drops falling through various distances has been completed. Fall velocities and drop-sizes in natural rainfall have been measured. High speed motion pictures were obtained of water-drops striking soil surfaces. Preliminary tests have shown that rain characteristics have a profound effect upon infiltration and rate of erosion.

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SOIL CONSERVATION SERVICE, Spartanburg Outdoor Hydraulic Laboratory.

(931) (a) STUDY OF THE EFFECT OF LINING CHARACTERISTICS ON THE HYDRAULIC BEHAVIOR OF CONSERVATION CHANNELS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Hurt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To obtain data on channel capacities for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) Measured flows are passed through outdoor test channels of various cross-sections and slopes, and precise measurements of the hydraulic elements are made to determine the effect of different linings on channel capacity. Special emphasis is placed on the study of vegetal linings.
(h) Vegetations tested to date include Bermuda, Centipede, Dallis, and Sudan grasses, as well as Lespedeza Sericea, Common Lespedeza, and Kudzu. Tests of soil-cement and cotton-reinforced bituminous linings are also under way.
(i) For further description see Civil Engineering, October, 1938.

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(932) (a) STUDY OF THE CAPACITIES OF NOTCHES AND OTHER APERTURES IN CONSERVATION STRUCTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Hurt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To obtain data on notch capacities for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) Full-size apertures of various shapes and dimensions are tested by passing measured flows of water through them. Additional data are obtained by testing models of the notches.
(h) One series of tests on rectangular notches of the type used in drop structures has been completed.
(i) For further description see Civil Engineering, October, 1938.

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(933) (a) STUDY OF ALLOWABLE VELOCITIES FOR VEGETAL CHANNEL LININGS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Hurt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To obtain data on the protective characteristics of various types of vegetation for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) The outdoor test channels used in the study of hydraulic characteristics of linings are also utilized for the determination of allowable velocities. For each vegetation the rates of scour are determined for flows of various magnitudes and compared with the scour rates for other vegetations and for unlined channels.

(h) Allowable velocities have been determined for all of the vegetal linings itemized in the description of the study of the hydraulic characteristics of channel linings.
(i) For further description see Civil Engineering, October, 1938.

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(934) (a) STUDY OF ALLOWABLE VELOCITIES FOR ARTIFICIAL CHANNEL LININGS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Durt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To obtain data on the protective characteristics of inexpensive artificial channel linings for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) Test channels lined with various types of artificial linings will be tested to failure under high velocity flows. The deterioration of these linings under weathering will also be studied.
(h) Tests on soil-cement and cotton-reinforced bituminous linings are under way.
(i) For further description see Civil Engineering, October, 1938.

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(935) (a) STUDY OF THE PROTECTION OF CHANNELS BELOW DROPS AND OTHER CONSERVATION STRUCTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Durt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To develop practical and inexpensive methods of preventing excessive scour below the structures constructed in soil and water conservation operations.
(g) A channel of adjustable height discharges water into a scour pit in which various types of aprons, pools, baffles, and other protective works will be constructed for test. The height of fall, the discharge and the characteristics of the protective works can be varied.
(h) The testing program is scheduled to begin during the spring of 1940.
(i) For further information see Civil Engineering, October, 1938.

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U. S. SOIL CONSERVATION SERVICE, ENOREE RIVER SEDIMENT LOAD STATION.

(937) (a) MEASUREMENT OF TOTAL SEDIMENT LOAD TRANSPORTED BY NATURAL STREAMS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) General research.
(d) Joe W. Johnson, Alvin G. Anderson, H. Albert Einstein.
(e) Chief, Soil Conservation Service.
(f) To provide a continuous record of the amount and composition of the suspended and bed loads carried by a natural stream. To correlate these data with the hydraulic functions of the stream and the topography, land use, and hydrologic conditions of the watershed.
(g) The bed load is removed hydraulically from the subdivisions into which the bottom of the river has been divided, while simultaneous observations are made of suspended load and velocities.
(h) Construction is completed and preliminary tests are now in progress at the station located on Enoree River near Greenville, S. C. Ten recording rain gages have been installed on the drainage area above the station.
(i) To supplement river observations a concrete flume 5 feet wide, 30 inches deep, and 50 feet long, provided with a constant-head tank, a weir, and a sand-feed elevator, has been installed.

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HYDRAULIC RESEARCH IN CANADA

ECOLE POLYTECHNIQUE DE MONTREAL.

(630) (a) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.
(b) Hydraulic Laboratory, Ecole Polytechnique de Montreal.
(c) General scientific research.
(d) Professor Raymond Boucher and assistant.
(e) Professor Raymond Boucher.
(f) To establish a comparison between the discharge capacities of different spillway designs.
(g) Studies are made on concrete models of existing and recommended spillway profiles. Pressure distribution on spillway crests and coefficients of discharge are determined for various heads up to the designed head. The effect of gate piers of various designs is also investigated.
(h) Experimental work in progress. Six different profiles have been studied.

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(1156) (a) THE DETERMINATION BY MODEL STUDY OF THE EFFECT OF CHANNEL DEPTHS ON WEIR COEFFICIENTS.
(b) The Shawinigan Engineering Co., Ltd.
(c) Model tests to determine the discharge of a spillway dam.
(d) Professor Raymond Boucher and assistant.
(e) Professor Raymond Boucher.
(f) To determine the effect of channel depths on the discharge coefficients of a spillway.

(g) Tests are made on a concrete model (scale 1:60) of a spillway crest with two gate piers. On the upstream side of the weir an adjustable wooden false bottom provides various depths of channel of approach. For different channel depths the coefficients of discharge are determined for various heads up to the designed head.

(h) Experimental work completed.

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ABSTRACTS OF COMPLETED PROJECTS AND REFERENCES TO PUBLICATIONS.

UNIVERSITY OF CALIFORNIA.

(720) EXTENSION OF MODEL STUDY OF CABRILLO BEACH.

Cabrillo Beach is an artificial sand fill constructed in 1927 in the angle formed by the line just east of Point Fermin and the San Pedro Breakwater near Los Angeles, California. Since completion it has been subject to continual erosion.

A scale model study of the beach, begun in 1938 and continued until April, 1939, was undertaken to secure information as to proper methods to be used in stabilizing the beach and preventing further erosion.

A model of the beach and vicinity to a scale of 1:50 was constructed in a tidal basin. Tides were produced by manual control of valves located in inlet and outlet pipes. Two identical wave-generating units were used, each consisting of a rigid frame supporting a D.C. motor which supplied power to the plungers through a train of gears. The plungers were constructed of sheet metal of an isosceles right-triangular cross-section.

Ten separate runs were made during which the effects of different groins and directions of wave attack on the beach were observed. In addition several different beach shapes were tested. Measurements of beach changes were made at regular intervals and numerous photographs taken.

The beach model was constructed according to the conditions imposed by Froude's model law. However, due to the inability to obtain sand for the model of the proper size, no attempt was made to obtain quantitative results as to sand movement or rates of change.

The results of this model study may be summarized as follows:

1. The beach under consideration was extremely sensitive to changes in direction of wave attack.

2. The littoral drift of sand was predominantly in one direction along the beach - from west to east.

3. For any one direction of wave attack, the beach became more stable as it tended to become more nearly parallel to the crest of the breaking waves at the plunge point.

4. A certain amount of sand was lost by being carried into deep water offshore and by being driven through the breakwater at the east end of the beach.

5. Most of the sand loss could be eliminated by sealing a portion of the breakwater adjacent to the beach and by the construction of a groin at the east end of the beach approximately at right angles to the breakwater.

(723) RECOVERY EFFICIENCY OF VARIOUS TYPES OF SLOWLY MOVING FLUID INTERFACES.

If the rate of advance of the oil-water interface is below 30 feet per day, the rate does not affect the recovery of the refined oils used from compacted silica sand.

The rate of advance of the oil-water interface materially affects the recovery of the crude oil from silica sand. Less recovery is obtained at very high (50 feet per day) and very low (0.045 feet per day) rates.

Large changes in the viscosity and interfacial tension of the oils used show no unique effect on the recovery.

Relatively small variations in the porosity and permeability of the sand do not uniquely affect the recovery of the oils.

Variations in recovery occur which are too large to be accounted for by experimental error when the rate, oil, temperature, permeability, and porosity are kept the same. This indicates that the pore configuration of the sand is an important factor in determining recovery efficiency.

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(726) THE AXIAL ADJUSTMENT OF DEEPWELL TURBINE PUMPS.

The effect of axial adjustment on deepwell turbine pumps depends upon the impeller design. The open impeller shows a decrease of capacity and efficiency at the same head with increase of axial clearance, while the open impeller is almost unaffected within the possible range of impeller position. The open impeller can be adjusted readily in the field to minimize the effect of wear. The corresponding adjustment of the normal closed impeller is not effective. These experimental results on new deepwell turbine pumps are presented without any intended implications regarding the suitability of either design for field conditions.

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(801) FRICTION OF ANGULAR-CONTACT BALL BEARINGS UNDER THRUST LOADS.

This investigation was undertaken in order to determine the contribution of the thrust bearings to the power losses in deep-well turbine pumps. A friction dynamometer was built in which two bearings are tested simultaneously by loading one against the other by means of a spring. The bearings were oiled by drip feed, and their operating temperature was controlled by spraying water over the outside of the bearing housing. One pair of bearings, size 215, was tested under loads of 1000 to 3000 lbs, and speeds of 900 to 2400 RPM.

It was found that, during the operation of the dynamometer, oil is accumulated and stored in the bearing housing despite the open drain provided in the bottom of the housing. The quantity of oil stored is a function of the design of the housing, the kind of oil used and the speed. For light turbine oil the quantity stored was found to be a maximum at the lowest speed and nearly zero at the highest. The churning of this oil adds to the friction.

Holding all other variables constant it was found that:

(1) The rate at which the oil is fed through the bearings has no appreciable effect on the friction.

(2) The friction decreases rapidly with increase of operating temperature.

(3) The friction coefficient increases linearly with speed.

(4) The friction coefficient decreases with increasing load up to 2000 lbs. For higher loads it is practically independent of the load.

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(803) MIXING OF STREAMS IN CLOSED CIRCULAR CONDUITS.

The purpose of this study was to compare measured losses at a 90° pipe junction with values given by theoretical investigation. On the whole, the agreement with theory was not good. Apparently certain simplifying assumptions used in deducing a workable equation are not valid. According to the theory, the ratio of the head loss in the junction to the velocity head based upon the combined flow should vary only with the relative amounts of water flowing in the side branches and not with the absolute values. This was found to be approximately the case for the higher rates of flow, but considerable divergence was found at lower quantities.

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(804) CHARACTERISTICS OF RECTANGULAR SLUICE GATES.

The purpose of this study was to determine the shape of opening and type of inlet transition for an undershot sluice gate which would exhibit a high coefficient of discharge. The following sizes were tested: 6" x 6", 6" x 4 1/2", 6" x 3", 6" x 1 1/2", 12" x 3", 12" x 1 1/2". The square opening was found to have the highest coefficient. The optimum radius of curvature for the transitions was found to be a function of the width-depth ratio of the gate. An empirical equation of the form $R/D = K\left(\frac{W}{D}\right)^{n}$ was obtained. Here R is the radius of curvature of the transition, D the depth of the gate, and W the width of the gate. The tests resulted in values of 4 for K and -0.80 for n.

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(806) OSCILLATORY WAVES.

The object of this experiment is to make a laboratory check of the hydraulic theory relating to oscillatory waves.

The apparatus used consisted of a trough or channel, a wave generator, a wave dissipator, and various devices for measurement of the waves produced. The channel was 60 feet long, 3 feet deep, and 1 foot wide with a double glass observation panel near its center. The wave generator was a wooden flap pivoted at the bottom of the channel and driven from its upper end by a rod attached to an eccentric wheel. The wave flap was at an inclination of about 13° to the horizontal. Cages were provided for direct measurement of wave amplitude, length, period, velocity of propagation, and velocity of mass transport at the surface. Particle traces were recorded photographically, making exposures through the glass panel on white particles having the same specific gravity as water.

Theory - References:

1. "Hydrodynamics" by Horace Lamb, pages 340-362, 393-396, 457-464. 5th Edition. Published by Cambridge University Press, London, 1924.

2. "On the Theory of Oscillatory Waves" by George G. Stokes, pages 197-230, Volume 1, Mathematical and Physical Papers, Cambridge University Press, 1880-1930.

3. "Scientific Papers" by John W. Strutt, Baron Rayleigh, Volume I, pages 261-264, 322-341, Volume V, pages 514-518, Volume VI, pages 6-14, 306-314. Published by Cambridge University Press, London, Volume I, 1899, Volume V, 1912, Volume VI, 1920.

Results:

Comparison of observed with theoretical velocities of propagation shows a mean discrepancy of less than 2%.

The shape of every particle orbit appears to be circular except as modified by mass transport.

Comparison of observed with theoretical orbit radii shows a mean discrepancy of 8.2%.

Every wave observed produced mass transport at the surface in the direction of wave propagation.

All photographs show translation of particles in the direction of the waves near the surface and in the opposite direction near the bottom of the channel.

The theory of mass transport is verified qualitatively and to some degree quantitatively.

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(807) TRANSPORTATION OF SAND IN PIPE LINES.

The most predominant feature brought out was that the friction factor and the head loss of a solid-water mixture was greater than that of water. Moreover, the greater the concentration of the mixture the greater become the head loss and the friction factor. These results are at variance with those of other investigators, who found that the friction factor and the head loss were independent of the concentration above the critical velocity.

Although the critical velocity was difficult to determine accurately, the research, nevertheless, brought out the point that the higher the concentration the higher the critical velocity. Below this critical velocity the head loss tended to become constant as the velocity was reduced. This phenomenon had been observed by previous experimenters.

It also appeared from this research, that in dealing with fine materials having low settling velocities the friction factor was not greatly affected when different materials of like concentration were flowing in the pipeline. This was especially true at the higher velocities.

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CALIFORNIA INSTITUTE OF TECHNOLOGY.

(661) THE USE OF HYDRAULIC MODELS IN THE DESIGN OF SUSPENDED LOAD SAMPLERS.

In flows carrying large particles in suspension, disturbances caused by the sampler will affect the local sediment concentration. Therefore, for unbiased results, no portion of the sampled fluid should be disturbed by changing its normal velocity, in either magnitude or direction, in arriving at the point where it is taken.

Sampler models were placed in a glass-walled flume, and dye jets injected into the flow showed the disturbance caused by the sampler. Two sampler types were chosen for these tests because they were apparently those showing most promise of being developed into instruments that cause little disturbance. One, the horizontal-tube type, consists of a cylindrical or prismatic tube, that may be held parallel to the flow, supplied with some means of being closed to trap a portion of the fluid. Another, the Eakin cutter-type sampler, traps a cylinder of fluid between two sealing disks when a spring actuated cutter tube slides over one disk and strikes the other.

Plots of the dye-stream paths were made for various modifications of the samplers, and these plots were used as a basis for new designs. These experiments have shown that satisfactory samplers may be built of both the cutter type and the horizontal-tube type, provided design principles based on these flow studies are observed. It was concluded, however, that the Eakin cutter-type sampler caused the least disturbance, and, therefore, it was selected for the development of improved mechanical designs.

Specifications and working drawings have been prepared for an improved model of the Eakin multiple-unit cutter-type sampler and for two line-suspended single-unit cutter-type samplers. Five units of the multiple-unit sampler, nine of one single-unit design, and four of the other have been constructed.

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UNIVERSITY OF IOWA.

(848) SPREADING OF A WATER JET ON A LEVEL FLAT FLOOR.

Cross sections were measured of the jet from a rectangular orifice with its bottom at the elevation of a level flat floor, as it spread out on the floor. Jets with ratios of height to width ranging from 3:1 to 1/4:1 were tested. The apparatus tested only half of a jet, i.e., that on one side of the vertical plane through the center line of the jet. (The ratios given above are for the full jet.) The sides of the orifices as tested ranged from 1 to 6 inches in length and the discharges reached a maximum of 1-1/3 sec.-ft. The approach surfaces to the orifices were streamlined so that there was no contraction of the jet due to the orifice.

The spreading of the jet was found to be due to a combination of two motions, (1) that due to the velocity of the water issuing from the orifice and (2) that due to the spreading of the jet in a direction at right angles to the initial direction of flow. This was the result of the internal pressure set up in the jet by the force of gravity, and the spreading was a function of time and the initial shape of the jet. For a given initial shape of jet, the shape of the cross-sections of the jet spaced at distances from the orifice proportional to the issuing velocities, were found to be nearly identical. From this relation and the model laws, the shape of any jet of the depth-width ratios tested, spreading on a level flat floor, can be closely predicted.

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(855) DIFFUSION CHARACTERISTICS OF TURBULENCE IN AN OPEN CHANNEL.

The experimental work in this project was devoted to a study of a method of measuring directly the diffusive power of the turbulence in an open channel. The experiments were made in a flume 2.5 feet wide, 3 feet deep, and 25 feet long, having glass sides and a steel bottom. The slope of the energy line was calculated, using Manning's formula with an assumed value of roughness factor, n. The velocity distribution was artificially established, to what was deemed desirable, by use of various baffles at the channel entrance. At the test section the mean longitudinal velocities were determined at various points with a calibrated pitot tube or a small current meter.

Studies were made for mean velocities of flow of 0.443 and 0.834 feet per second for depths of 1.25, 1.00, and 0.50 feet.

The diffusion measurements were made by injecting through a fine tube a mixture of carbon tetrachloride and benzine having the same specific gravity as water. This mixture was made black with an aniline dye. This immiscible liquid formed well-defined droplets which were photographed on motion picture film. The values of mean Y^2 were calculated for various distances X, downstream from the point of droplet injection; Y being the transverse travel of any single droplet.

The variation of $\overline{Y^2}$ with X was found to check that predicted by G. I. Taylor's theory of diffusion in turbulent flow. According to this theory the turbulence diffusion coefficient D is equal to the maximum value of $\overline{U}/2\ (d\overline{Y^2}/dx)$, where $\overline{U}$ is the mean forward velocity at the point considered. This value of D was determined for various points in the cross-section of the channel and was found to approach zero at the bottom, attain a maximum value at the mid-depth, and again approach zero at the surface. It was found that the eddy-viscosity coefficient, ϵ, as computed from the equation for shear and velocity distribution, was similar in general to D both in magnitude and variation from bottom to surface.

The frequency distribution of values of Y at any point X corresponded to the normal error law. Measurements were also made of the root-mean-square values of the fluctuating vertical and longitudinal velocity components. The variation from bottom to surface of these values was determined for the different mean velocities and depths of flow.

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(856) THE HYDRAULICS OF CULVERTS.

Reports on studies of flow through culverts, friction in concrete and corrugated iron pipes, elevation of the hydraulic grade line at the outlet of an unsubmerged pipe, and effect of degree of entrance rounding on entrance loss were abstracted and analyzed. Tests were made on a transparent model pipe culvert 3 3/4 inches in diameter and 51 inches long. Loss of head at entrance when the pipe flowed full with inlet and outlet submerged was determined by measuring the difference between headwater and tailwater elevations and subtracting the sum of friction head, computed by Blasius' formula, and velocity head. Entrance losses in terms of velocity head with square-edged entrance and with entrances rounded to radii of 1/16th inch, 1/8 inch, 1/4 inch, 3/8 inch, and 1/2 inch were 0.48, 0.42, 0.29, 0.23, 0.16, and 0.14, respectively, at velocities between 0 and 5 feet per second. Water surface profiles within the pipe when it flowed partly full were recorded photographically. Discharges through the pipe with 1/16 inch radius rounded entrance were about 10% less than discharges computed on the assumption of critical flow at the entrance. When the culvert flowed full with its outlet unsubmerged, the point at which the hydraulic grade line pierced the plane of the outlet varied from near the center of the pipe (velocity 5 feet per second) to near the top (velocity 2 feet per second).

The work was done as a master's thesis by A. E. Luecker, under the direction of Dr. F. T. Mavis.

POLYTECHNIC INSTITUTE OF BROOKLYN.

(798) STUDY OF CRITICAL-DEPTH METER.

One purpose of this study was to compare the measured critical depth on the crest of the weir with the computed or theoretical value.

For flows ranging from 0.3 to 1.3 cfs the position of the theoretical value of critical depth was found to be somewhat downstream from the crest of the weir, while for discharges up to 2.3 cfs it was upstream. The rate of flow was calculated accurately by the introduction of a coefficient of discharge, so that the formula became $Q = C\, B\sqrt{g}\, D_a^{1.5}$ (D_a = measured value of critical depth). Values of "C" were plotted with respect to discharge. But, again, in order that the broadcrested weir be practical as a critical-depth meter, these values of "C" should remain constant. The results showed that this does not occur.

It appears that the design of a weir of constant coefficient presents fewer difficulties than the design for which critical depth occurs at the same location at all heads.

The surface profiles over the weir for a small, a medium, and a large rate of flow were obtained by actual measurement, by an analytical method, and by a graphical method. The measured, graphical, and analytical curves in each case became superimposed at the crest of the weir. Each set of curves showed similar characteristics. The actual measured profile in each of the three cases was lower than the theoretical curve upstream, but above, downstream. From these three sets of curves it can be seen that as the rate of flow increases, the theoretical and actual profiles become farther apart. This is to be expected because the losses become more effective.

The critical depth meter as designed was satisfactory for only a part of the range of flows used.

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NATIONAL BUREAU OF STANDARDS.

(977) MATHEMATICAL THEORY OF FLOOD WAVES.

The irrotational motion of a perfect liquid in a horizontal rectangular canal when the original liquid surface is disturbed is investigated on the assumption that the horizontal velocity of the liquid particles in a cross section is approximately uniform. Special emphasis is laid on disturbances which are propagated without change of form, and for these disturbances formulas are derived for the wave profile and velocity of propagation. Formulas are also derived which give the deformation, energy, motion of the center of gravity, and moment of instability of an arbitrary intumescence. Where possible, the formulas have been compared with available experimental data. Of special interest is the comparison of the shape of the undulations composing the head of an initial surge with the characteristics of the cnoidal wave.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

Publications available.

Copies of the following publications will be furnished without charge to hydraulic laboratories, upon application: "Hydrologic Research", by R. E. Horton, Science, Vol. 86, No. 2241, Dec. 10, 1937, pp. 527-530. "List of Publications, with Abstracts" by R. E. Horton, Publication No. 112, with Supplement No. 1, Horton Hydrologic Laboratory. This catalog contains abstracts of over 120 publications of the Horton Hydrologic Laboratory, with prices of those which are available for distribution.

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1. R. Lallekegger. Process of changes of moisture in calcareous clayey soils.
2. J. Einwachter. Practical examples of the hydraulics of currents.
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2. B. Taxner. Problems of the Pest-County Danube Valley Drainage and Irrigation Company.
3. G. Lapray. Examination of the lucrative character of irrigation in Italy.
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2. K. Frisch. Hydraulic works carried out during the 20 years' Czech Imperium.
3. E. Serf. Construction of the aqueduct joining up the pumping plant at Tiszaföred.
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The following translations have been made at the University of Minnesota. Inquiries should be addressed to Lorenz G. Straub, University of Minnesota. Translations have been made with assistance from Works Projects Administration.

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INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ROUND-TABLE DISCUSSION

on

THE ROLE OF HYDRAULIC LABORATORIES IN GEOPHYSICAL RESEARCH.

held at the

NATIONAL BUREAU OF STANDARDS

on

September 13, 1939.

Chairman: Herbert N. Eaton, National Bureau of Standards.

The following program of papers was presented at the Round-Table Discussion:

Topic 1(b). DENSITY CURRENTS.
Reporter's discussion*. R. T. Knapp, California Institute of Technology.
"Density Currents in Norris Reservoir", A. H. Wiebe, Tennessee Valley Authority.
"Density Current Investigations at Lake Mead", Tom C. Mead, U. S. Bureau of Reclamation.

Topic 2(a). WIND WAVES ON WATER.
Reporter's discussion*. G. H. Keulegan, National Bureau of Standards.

Topic 2(b). OCEAN WAVES.
Reporter's discussion*. A. C. Lieber, Jr., Beach Erosion Board, Corps of Engineers, U. S. Army.

Topic 2(c). ROLL WAVES IN STEEP CHANNELS.
Reporter's discussion*. H. A. Thomas. Carnegie Institute of Technology.

Topic 3. TIDES AND SEICHES.
Reporter's discussion*. J. M. Caldwell, U.S. Waterways Experiment Station.

Topic 4(a). FLOOD WAVES.
Reporter's discussion. M. Bernard, U. S. Weather Bureau; and F. T. Mavis, Pennsylvania State College.

Topic 4(b). VELOCITY DISTRIBUTION.
Reporter's discussion*. C. H. Pierce, U. S. Geological Survey.

Topic 5. INFILTRATION AND RUNOFF.
Reporter's discussion. H. R. Leach, U. S. Soil Conservation Service.
"Notes on the Theories and Methods of Evaluating Rainfall and Runoff Indices", W. B. Langbein, U. S. Geological Survey.

Topic 6. GROUND WATER, PERMEABILITY, SPECIFIC YIELD, ETC.
Reporter's discussion*, O. E. Meinzer, U. S. Geological Survey.
"Notes on Model Studies of Ground-Water Movements", F. T. Mavis, Pennsylvania State College.

Topic 7(a) WIND EROSION, DUNES, ETC.
Reporter's discussion*, C. J. Whitfield, U. S. Soil Conservation Service.

Topic 7(b) EROSION AND DEPOSITION OF SOIL BY WATER.
Reporter's discussion, H. L. Cook, U. S. Soil Conservation Service.

Topic 7(c) STREAM AND VALLEY EROSION AND DEPOSITION.
Reporter's discussion*, S. C. Happ, U. S. Soil Conservation Service.

Topic 7(d) SILTING OF RESERVOIRS.
Reporter's discussion*, L. M. Glymph, Jr., U. S. Soil Conservation Service.

Topic 7(e) FORMATION OF RIFFLES BY WATER.
"Bancs de Sable et Ripple-Marks dans les Cours d'Eau", by L. J. Tison, Gentbrugge, Belgium.

Topic 8(a) TRANSPORTATION OF SEDIMENT BY STREAMS: BED LOAD.
Reporter's discussion*, Joe W. Johnson, U. S. Soil Conservation Service.
"Some Suggestions for Future Development of Bedload Studies", H. A. Einstein, U. S. Soil Conservation Service.
"Soil Conservation Service Bedload Measurements", A. G. Anderson, U. S. Soil Conservation Service.
"Geophysical Research in Natural Phenomena Involving the Transportation of Solids", S. Shulits, Corps of Engineers, U.S.Army.
"The Different Approaches to the Study of the Propulsion of Granular Materials and the Value of their Coordinated Study", Paul Nemenyi, Iowa Institute of Hydraulic Research.

Topic 8(b) TRANSPORTATION OF SEDIMENT BY STREAMS: Suspended Load.
Reporter's discussion*, Hunter Rouse, U. S. Soil Conservation Service.

Topic 9. SETTLING VELOCITY AND THE ORIENTATION OF PARTICLES.
Reporter's discussion*, W. C. Krumbein, University of Chicago.

Topic 10. SHORE LINE PROCESSES.
"The Munch-Petersen Formula for the So-called 'Coastal Transportation Force'" Paul Nemenyi, Iowa Institute of Hydraulic Research.

Topic 11. METEOROLOGICAL PHENOMENA.
Reporter's discussion*. R. T. Zoch, U. S. Weather Bureau.

Topic 12. INSTRUMENTS AND METHODS OF MEASUREMENT.

Reporter's discussion*, J. C. Stevens, Stevens and Koon, Consulting Engineers.

"American Suspended Sediment Samplers". E. W. Lane, Iowa Institute of Hydraulic Research.

"Velocity and Discharge Measurements in the Hydraulic Laboratory", M. A. Mason, National Bureau of Standards.

"Mechanical Aids to the Hydraulic-Model Engineer." Wright Hiatt, U. S. Waterways Experiment Station.

MISCELLANEOUS.

"The Problem of Air and Water Movements over Irregularities of the Ground", A. B. Dobrowolski, Poland.

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* A few mimeographed copies (without figures) of these discussions are available for distribution. Apply to H. N. Eaton, Chairman, Round-Table Discussion, National Bureau of Standards, Washington.

The papers listed in the above program, together with brief discussions presented orally, are to be published by the International Union of Geodesy and Geophysics as part of the program of the Washington Assembly in 1939.

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HYDRAULIC RESEARCH COMMITTEES.

Committee on International Bibliography, Section of Hydrology, American Geophysical Union.

The Committee has published three issues of "Bibliography of Hydrology for the United States" covering the years 1935-6, 1937, and 1938. A few copies of the last two issues are still available at 30 cents each.

It is expected that a similar bibliography covering the year 1939 will be published early in 1940. It will contain some 400 references with abstracts of nearly all. Distribution will be to subscribers only. Non-members of the Union who wish to subscribe should send names and addresses, and remittance at 50 cents per copy, to the Secretary of the Section: K. Hilding Beij, National Bureau of Standards, Washington, D. C. (Stamps, money orders, or checks)

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NATIONAL RESEARCH COUNCIL INTERDIVISIONAL COMMITTEE ON DENSITY CURRENTS.

Chairman: Herbert N. Eaton, National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C.

Members.

J. H. Bodine	C. S. Howard	C. S. Scofield
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R. A. Hill	H. Peters	A. H. Wiebe
P. V. Hodges	F. P. Shepard	

* Alternate: G. C. Dobson.

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Subcommittee on Elephant Butte Reservoir.

Chairman: C. S. Scofield, Chief, Division of Western Irrigation Agriculture, Bureau of Plant Industry, U.S.Department of Agriculture, Washington, D.C.

Members. M. M. Ellis, M. A. Mason, L. R. Fiock*, C. B. Brown, C. S. Howard

* Alternate: W. F. Resch

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Subcommittee on Lake Mead.

Chairman: C. P. Vetter, U. S. Bureau of Reclamation, Customhouse, Denver, Colorado.

Members. M. M. Ellis, C. S. Howard, T. C. Mead.

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The Chairman of the Committee presented a brief progress report to the Division of Geology and Geography of the National Research Council on April 29, 1939. Copies can be obtained from the Chairman.

The Committee held meetings at Washington, D. C., on November 17 and 18, 1939. Copies of the minutes will be available shortly upon application to the Chairman.

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Hydraulics - General.

Hydrology.

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Machinery - Hydraulic.

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Miscellaneous.

Model Tests - Coasts, Harbors.

Model Tests - Streams.

Model Tests - Structures.

Open Channels.

Percolation, Permeability.

Pipes and Fittings.

Plumbing.

Sediment - Transportation, Erosion, Settling, Analysis.

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